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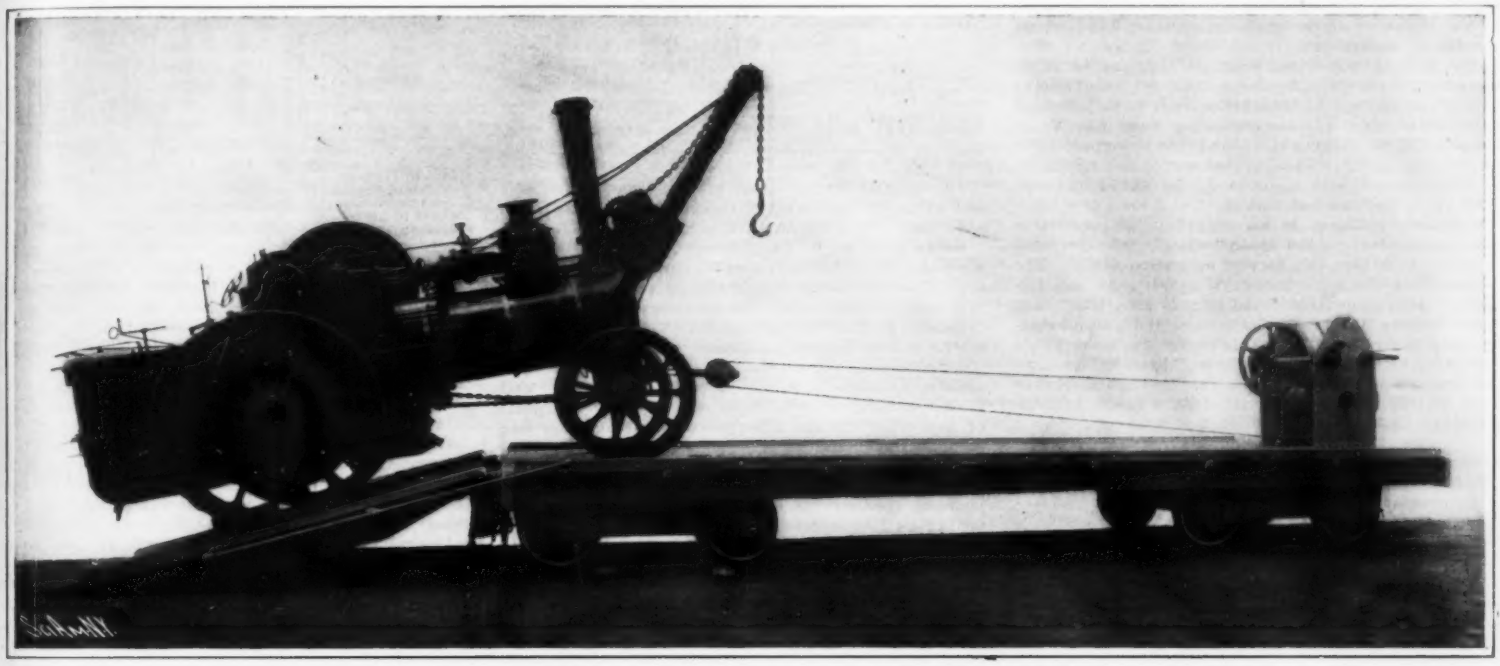
NEW BOGIE TRANSPORT CARS.*

By Emile Guarini.

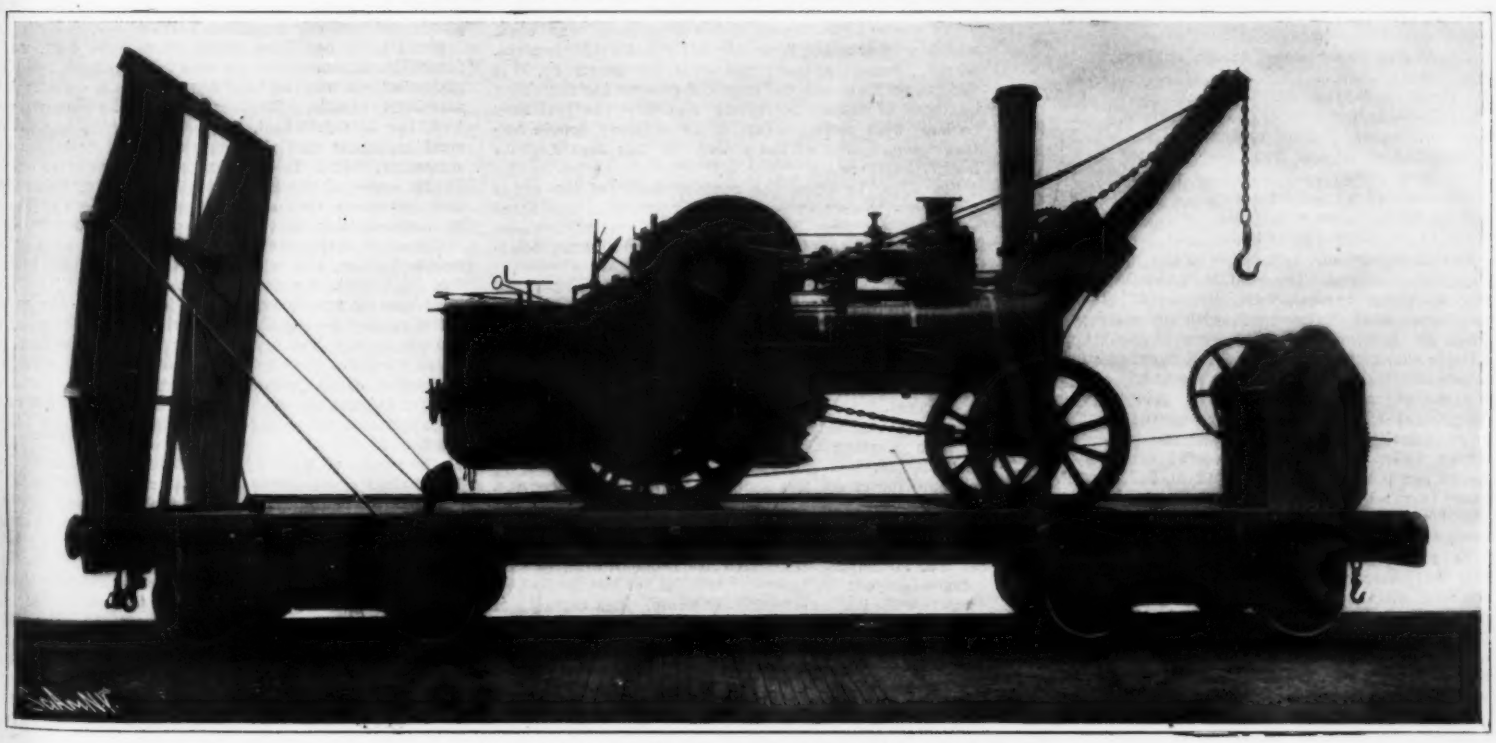
Eight cars have been recently constructed by the Leeds Forge Company, Ltd., for transporting one of Messrs. Fowler's steam plowing engines, or, when required, one of their plows or cultivators. They are for use on a private Egyptian railway. It was found, when the test was made on one of these cars in the makers' works, that the time occupied in lowering the incline, hauling the engine up on the car, and again raising the incline into its running position, was less than half an hour, though these operations can be carried out in considerably less time when the men get used to them. It may, however, be explained that the test was carried out with an ordinary works traction engine, with jib crane to represent the plowing engine for which the cars are really designed. The bogies for these cars are constructed of Fox's pressed-steel frame plate.

It will be noticed that each car is provided with an inclined plane, hinged to the end of the underframe. This can be lowered onto the rails, when a hand winch on the other end of the car allows of the traction or plowing engine being hauled upon the car or removed therefrom. When the car is running, the plane is lifted to a vertical position, and there secured by stays. The buffers on the plane end of the underframe are hinged at the bottom, so that by taking a cotter out of the top, they will drop out of the way of the plane. Struts are also placed under this end of the car. These require to be adjusted slightly above the rail level to take a portion of the weight while the engine is over the same, and thus prevent the underframe being strained through the whole of the load being carried over one bogie. It is not, however, necessary to use these struts when the plow or cultivator is being placed on the car, as these machines are of course considerably lighter than the engine. The struts can be placed out of the way on a hook under the headstock when the car is running.

The winch is designed to give a pull of three tons from the barrel when working with double purchase, i. e., a total pull of 6 tons is available when using the snatch block on the engine for hauling the latter onto the car. The weight of the plowing engine is 22 tons. The method of raising and lowering the end plane is by passing the rope from the winch through a snatch block, which is attached to the underframe,



THE INCLINE LOWERED FOR HAULING THE TRACTION ENGINE ON THE CAR.



TRACTION ENGINE ON THE CAR WITH THE INCLINE LIFTED.

NEW BOGIE TRANSPORT CARS.

* Specially prepared for the Scientific American Supplement.

and then over struts on the plane, which struts can be lowered to the level of the floor out of the way, when the engine is being hauled up the plane. The same snatch block is also used to be attached to the engine and the rope passed through same and back to a hook under the winch, in order to give sufficient power for lifting the engine.

[Concluded from SUPPLEMENT No. 1571, page 25168.]

LIQUID FUEL FOR NAVAL AND MARINE USES.*

By Rear-Admiral GEORGE MELVILLE, Former Chief Engineer, United States Navy.

Liquid Fuel in the Merchant Marine.

OIL has not, as yet, been extensively used as a fuel in merchant vessels. By reason of its convenience in handling, the reduction of the force required to operate the boilers, and the fact that the latter may be worked more uniformly, there seems no doubt that the substitution of oil for coal would be favored by many engineers if there were not also disadvantages in increased cost, the lack of an assured supply, and difficulties in the structural and transportation features of the problem. Except upon the Pacific coast of the United States, and in certain portions of the East Indies, there has been, therefore, no marked disposition to use liquid fuel for marine purposes on an extensive scale. A few instances of its employment may, however, be considered with profit.

The performance of the steamer "Mariposa" was investigated thoroughly, by my orders, in 1902. She is a single-screw vessel, 3,160 gross tons, 2,500 indicated horse-power, and was then running from San Francisco to Tahiti, making the round trip voyage of 7,320 knots each month. The engines are of the triple expansion type. There are two double ended and one single ended cylindrical boilers.

Oil tanks sufficient in capacity for the round trip were constructed in the space formerly used for coal bunkers, with also two service or setting tanks. The "Grundell & Tucker" burner was fitted in the furnaces. Air, compressed to 30 pounds as a limit, was the atomizing agent. It was used at the heat of compression or as heated by the air heater, the latter being a part of each furnace-front formed by a hollow casting through which the air passes. California oil was used, having, on ultimate analysis, the following composition:

	Per cent
Carbon	84.43
Hydrogen	10.99
Nitrogen	.65
Sulphur	.59
Oxygen	3.34

This gives a calorific value, by Dulong's formula, of 18,806 British thermal units. The specific gravity at 60 deg. F. is 0.962. Flash point, 228 deg. F. Fire point, 258 deg. F. Vaporization point, 178 deg. F. Loss for six hours at 212 deg. F., 12.01 per cent.

During a voyage from San Francisco to Tahiti and return, observations were made by Lieut. Commander Ward Winchell, U. S. N., the principal average results being:

Indicated horse-power (main engines only)	2,481
Revolutions per minute	68.05
Indicated horse-power, main engines, per square foot of grate	9.661
Pounds of oil per hour per indicated horse-power	1.503
Pounds of oil per knot run	273.6
Knots made per ton of oil	8.201
Slip of screw, per cent	12.97

During subsequent voyages, a slight increase in efficiency was secured. The officials of the Oceanic Steamship Company furnished the Bureau of Steam Engineering, United States navy, with an abstract of the steam-log of twenty-three voyages of the "Alameda," a sister ship of the "Mariposa," but running on a faster schedule. The principal results were:

Eight voyages made with coal; machinery in fair adjustment only, coal a mixture of British Columbia and Australia production, having an evaporative efficiency under a test boiler (Scotch) of 7.5 pounds of water per pound coal, from and at 212 deg. F.; distance traveled, 33,154 miles; coal required to drive the vessel one mile, 465 pounds. The percentage of ash varied between 16.7 and 24.5.

Seven voyages made with oil as fuel; machinery in fair adjustment only, inexperienced men operating burners, distance, 29,078 miles; oil consumed, 28,183 barrels; relative efficiency, in weight, of oil-fuel and the inferior grade of coal noted, 1 to 1.42. As a pound of this oil costs less in San Francisco than a pound of any grade of coal for marine purposes, the economy of using the oil in this case is apparent.

Eight voyages made with oil as fuel; machinery well adjusted and burners efficiently operated; pounds of oil required to drive the ship through one knot, 300; relative consumption of oil as compared with coal, 1 to 1.55.

A more uniform pressure was carried in the boilers with oil as fuel. The average time required to make the voyage was reduced a few hours. On the "Mariposa," in the change from coal to oil fuel, the total of the engineers' force was reduced from 36 to 20 men, of which final force, 3 were water tenders and 6 were firemen.

Measurably favorable results were also obtained with the oil fuel installation of the steamers "Nevada" and "Nebraskan," of the American Hawaiian Steamship Company. These sister ships are of about 8,900 tons displacement, 3,000 indicated horse-power, and 12.5 knots speed. The engines are of the triple expansion type and there are two Scotch boilers having a total grate surface of 162 square feet. The oil burner used on the "Nebraskan" is of the "Lassoe-Lovekin" type, the essential feature of which is a plug with radial holes fitted at the discharge end. Either air or steam can be used for spraying, the former preferably. The air for combustion and spraying is heated by the Howden system. In order to make the oil flow readily, it is heated by a steam coil fitted around the suction pipe. The furnace is lined with fire brick for the full length of the bottom and for about 2 feet from the front on the top, with a vertical lining to the back combustion chamber wall up to the height of the top of the furnace. Retarders, having a convolution for each foot of length, are fitted in the majority of the tubes. The following data refer to three voyages of the "Nebraskan," the first from New York to San Diego, Cal., the second, the return passage, and the third from New York to San Francisco.

Voyage	1	2	3
Fuel	Coal	Cal. oil	Texas oil
Distance run by ship, knots	13,290	12,726	13,135
Distance run by propeller, knots	15,076	15,252	15,496
Displacement, tons	8,300	8,417	8,576
I. H. P., total	1,845	2,196	2,220
Fuel per I. H. P., pounds	2	1.10	1.12
Miles per ton of coal, Eureka	6.16		
Miles per ton of coal, Coronel	5.53		
Miles per barrel of oil		1.44	1.36
Gravity of oil		15° B. at 60° F.	22½° B., 60° F.

The regular watch, when the ship was under way and using oil, consisted of 1 engineer, 2 oilers, 1 furnace man, and 1 wiper. When using coal there were 5 men on watch in the fire-room, instead of two as with oil. Four hundred and fifty-seven tons of measured space for cargo was saved by reason of the oil fuel being of less bulk. The insurance risks were not increased by the oil installation. The Howden draft system was of decided advantage.

As an example of careful tests, conducted on a scale sufficiently extended to secure fair results, I may call attention to a series of runs of the steamer "Tebe," carried out under the supervision of the engineer Salvatore Orlando of the Navigazione Generale Italiana. The Revista Maritima, March, 1904, says:

"The steamer 'Tebe' of the Navigazione Generale Italiana, recently made a voyage for the purpose of testing oil fuel in combination with a 'Korting' spraying burner. In view of the good results secured during these tests, it is deemed desirable to give some data concerning the working of the installation.

"The 'Tebe' has a triple-expansion engine, built by the Odero works, of 1,973 indicated horse-power. Steam is supplied by two double-end Scotch boilers of six furnaces each, the entering air being heated by the Howden system. The total heating surface is 6,458 square feet, with heating tubes fitted with retarders.

"In these experiments Texas petroleum was used, which was obtained from the oil depot at Alexandria, Egypt. Being in the crude state, or nearly so, this fluid is very viscous and does not possess the searching qualities of refined petroleum, and thus the fuel may be kept with perfect safety in an ordinary double bottom compartment of the vessel. It was thus kept on board the 'Tebe.'

"In order to allow the noxious gases of the crude petroleum to escape, every oil compartment was fitted with pipes rising above the upper deck, with elbow extremities inclosed in a safety casing turning downward.

"The point of ignition of the fuel used was found to be quite high. Partial ignition only occurred at 196 deg. F. and complete ignition at 230 deg. F. This is considerably beyond the minimum limit of safety required by Lloyd's in London. The density of the fluid burned was 0.931 at 60 deg. F., 0.905 at 130 deg. F.

"It contained less than 1 per cent of sulphur and the residue of ashes was 0.021 per cent.

"The Korting Company, which made the oil-fuel installation, had guaranteed to secure an output of evaporation of not less than 2.865 pounds of water at a steam pressure of 190 pounds with feed water at 158 deg. F. This heating of the feed water was obtained by means of an ordinary Weir heater.

"For measuring the feed water the following method was employed: A reservoir or tank for the feed water was installed alongside the air pump. The capacity of this receptacle was accurately measured and subdivided into quantities of 26.4 gallons by appropriate marks on the gage glass with which it is fitted. At the moment of observation the suction of the feed pumps was closed, so that the water, after filling the chamber of the air pump, flowed into the tank and indicated the height in the gage.

"By measuring with a second counter the time employed in passing from one measure to another, the attendant could deduce the feed water per hour corresponding to the rate of the engine at that moment.

"Simultaneously the quantity of oil consumed was accurately measured by noting the drop of the oil in the gage glass. There were thus obtained the two factors essential for determining the quantity of feed water evaporated per unit of liquid fuel.

"A careful observation showed that 52.8 gallons of water at a temperature of 96.8 deg. F. were evaporated every fifty-four seconds. There was an hourly consumption of 280 gallons of oil, and as the density of the oil, as previously stated, was 0.905, the consumption per hour by weight was 2,112 pounds. The quantity of feed water evaporated per hour may be assumed to be about 20,000 pounds, and therefore the evaporation of water per pound of fuel was 13.77 pounds.

"Except for the fact that the steam jet appliance—which had been installed for clearing obstructions which formed on the nets of the filter—proved inadequate, the general operation of the plant was very satisfactory.

"As the entire oil-fuel installation had been favorably passed upon by a government board of experts, the steamer was enabled to start on December 27, 1903, to Alexandria.

"During the first period of the voyage—from Genoa to Leghorn—the objectionable feature of obstructions forming on the nets of the filters having again appeared, all the nets were taken off, with the exception of that of the filter on the suction pipe. In this manner the deposits, which were nothing other than combustible matter, were thrown into the furnace. The work then became regular, and the voyage to Alexandria was completed without further inconvenience.

"During the various runs several experiments were made with forced draft and fuel consumption noted, which are summed up in the following table:

Route.	Duration of observation.		Oil consumed.	Consumption per hour.	Mean number of revolutions per minute.	Mean development in indicated horse power.	Consumption per indicated horse power per hour.
	H.	M.	Lbs.	Lbs.			Lbs.
Genoa to Leghorn	2	44	5,692.5	2,016.8	84.9	1,923	1.067
Leghorn to Naples	17	40	36,270	2,059.5	85.2	2,012	1.035
Naples to Messina	11	21	23,225	2,046.2	83.4	1,854	1.087
Messina to Alexandria (Egypt)	44	50	88,919	1,983	84.2	1,903	1.027

"The operation of these mechanical burners was not accompanied by any noise. Not only did the steam pressure remain constant, but the level of the water in the boilers was always maintained. The labor and care of operating the installation was therefore reduced to a minimum. It was also observable that there was a slight variation of temperatures in the fireroom.

"In this first voyage there was quite a loss of fuel, due to the fact that the filters and the burners had to be repeatedly dismantled in order to examine and clean them. There was also resulting loss of oil from the attendant which followed the examination and dismantling of burners and filters.

"Eliminating unusual losses of oil, it may be assumed that the Texas petroleum as secured from the oil depot at Alexandria and burned with a Korting apparatus in an ordinary Scotch boiler fitted with the Howden draft system will result in a consumption of about 1 pound of fuel per horse-power for marine purposes where there is an ordinary triple expansion engine. The consumption of Cardiff coal under like conditions may be assumed to be never less than 1.50 pounds of fuel per indicated horse-power."

From what has been shown, it appears that, under favorable circumstances as to quality, supply, and installation, oil may be used with economy as a fuel in merchant vessels. With regard to the storage and handling of liquid fuel, it is clear that, in certain directions, ample and rigid precautionary measures are necessary. Mr. J. B. Warner, the representative on the Pacific coast of the Hartford Steam Boiler Inspection and Insurance Company, summarizes the experience of many users in recommendations, as follows:

For small independent tanks, not forming part of the double bottom, and which tanks are not more than 4 feet in height, the shell plates should be of steel of good quality and heavy enough to prevent the seams being opened by the motion of the ship or surging of the oil in any weather. It is recommended that for ocean steamers the shell plates of these tanks be five-sixteenths of an inch in thickness. Where tanks of greater heights are contemplated, Lloyd's or other rules as applicable to water-tight bulkheading should be used.

The seams of large cylindrical tanks should be double chain riveted sheets laid close and well calked.

It is also recommended that the rivet holes be drilled instead of punched. They will then be fair, and rivets can be driven to properly fill the holes to prevent leakages.

In long tanks, suitable baffling or swash plates should be put in and securely fastened, to prevent the oil from surging. Under each small tank, when the tank is separate from the ship's structure, there is required to be a drip pan. This should be of lead weighing not less than 8 pounds to the square foot.

In deep tanks, when forming part of the structural portion of the vessel, special attention should be given to the proper and ample proportioning of the bulkhead stiffeners.

There should be no openings cut into the bottom, sides or ends of the tanks; all inlets and outlets must be through the top.

Reinforcing flanges should be of wrought steel and properly riveted to the top of the tank for filling, suction, and vent pipes. All filling pipes should run to the bottom of the tanks, so that when the tanks are filled the gas will be expelled through the vent pipes.

The man-plate opening should be of ample size (11 by 16 inches may do) to facilitate getting into the tank for any purpose. The vent must have an area equal to the diameter of the filling pipe, and should be carried up above the superstructure of the vessel and have

* Paper presented before the Congress of the Permanent International Association of Navigation Congresses.

a non-return bend on the end and covered with a fine copper-wire gauze screen.

No fuel oil is allowed to be carried in the water bottoms under the engine or boiler rooms on steamers.

"Davie" safety lamps should be provided for engineers and for all directly employed in the firerooms, so that if the electric light plant is shut down they can be used in place of an open flame lamp. The regulations of the United States Steamboat Inspection Service require that for oil burning on freight vessels there shall be valves fitted in the connection between the supply tank and the boiler. With such a valve installed the flow of oil at all times can either be regulated or cut off in case it is desired to extinguish or check the fire. Where more than one tank is used for stowage of oil, and such tanks are connected for discharge of oil from one tank to another, arrangements must be made whereby such valves can be manipulated from the main deck of the steamer.

Liquid Fuel in Naval Vessels.

Italy, more than ten years ago, led the advance in the investigation and solution of the problem of oil fuel as applied to ships of war. As a result of the researches of her experts in this matter, the majority of her vessels were equipped to use crude oil as an auxiliary to coal, for emergency uses in getting up steam and in full speed firing. Her example has been followed, to some extent, by other nations.

At the beginning of the war now in progress in the Far East, Russia had fitted for liquid fuel six battleships, one armored cruiser, and one protected cruiser. Germany was also early in the field and the use of oil is now being extended in her navy. The Imperial yacht "Hohenzollern" has an oil-installation and the new battleships of the "Braunschweig" type carry 200 tons of oil in their double bottoms. Others of the larger ships and several torpedo boats are also equipped for the use of oil.

In noting the comparative economical efficiency, for naval purposes, of oil and coal, there must be taken into consideration the fact that a ton of oil can be stowed in somewhat less space than a ton of bituminous coal. Then, again, it must be considered that in the carrying of oil the compartments can be more completely filled. The relative efficiency of oil and good steaming coal from the naval standpoint of fuel supply in warships may thus be regarded as in the ratio of 18 to 10.

From the results of the exhaustive tests carried on by the Liquid Fuel Board of the United States navy, I am of the opinion that, in regard to the evaporative efficiency, a long ton of the best quality of coal, such as Cardiff or Pocahontas coal, is equivalent to four and one-half barrels of oil; and that, in a long ton of an inferior quality of coal, the evaporative effect will be that obtained from only three to three and a half barrels of oil. This comparison is based upon the assumption that, until greater volume is permissible for the installation of naval boilers, it will not be possible to secure, in actual naval practice, an evaporation from and at 212 deg. F. of over 14 pounds of water per pound of oil fuel. Increased efficiency, however, may be secured by heating the air requisite for combustion, as in the Howden or some similar system, whereby the heat of the escaping gas is utilized for raising the temperature of the entering air requisite for combustion.

The mechanical or engineering feature of the oil fuel problem has been practically solved. The financial feature should not be regarded as of serious importance in the solution of any naval fuel problem, since it would be just as logical to fill the magazines of a war ship with an inferior quality of powder as to stow the bunkers with a poor steaming fuel. The question of cost as to fuel supply for naval purposes should not, therefore, receive undue consideration.

At the present time it is the structural, transportation, and supply features which present the only serious difficulty to the adoption of the use of liquid fuel by the navies of the world.

The transportation and supply features may be regarded as the commercial side of the problem. As engineer-in-chief of the United States navy, in my annual report for the year 1902, I said, as to this phase of the question:

"The commercial feature of the liquid fuel problem relates to the question of cost and supply. It may be regarded as a certainty that, except wherein unusual conditions prevail, the cost of oil for marine purposes will generally be greater than that of coal. The cost of oil, however, is less for vessels departing from the Gulf and California sea-ports, but the rule will probably hold elsewhere. While the question of cost should be of secondary importance in military matters, it must be taken into consideration in industrial matters. It is the expense of transportation that now prevents the oil from being a cheap combustible for marine purposes, but this disadvantage ought to be soon removed. While the oil may be put in the tank steamer very cheaply at ports like Point Sabine, its commercial value will be determined by the cost of delivery at commercial and maritime centers. This feature of the problem is beyond the ability of the navy to control, but it must be regarded as an important phase of the subject.

"In considering the matter of cost the fact should be remembered, however, that but comparatively few tank steamers are carrying oil between Point Sabine and the North Atlantic seaports. The expense of fitting up these vessels has been very heavy, due to the fact that unexpected difficulties developed in the costs of making the installations. This has compelled the owners of the oil steamers to charge comparatively high prices for transportation of the fuel. It can certainly be expected that when a large fleet of vessels are used for carrying oil and when terminal storage facilities are provided that there will be a material decrease in the price of oil in the leading cities of the coast. This is a very important commercial phase of the question, and should be carefully considered in determining the probable relative value of the two combustibles in the early future.

"It is undoubtedly a fact that the transportation charges per mile for oil at the present time are excessive compared with the freightage for coal, and this incongruity of expense account against oil cannot continue much longer.

"As regards the question of supply, it may be more expensive if not difficult to transport and to store oil than coal. The fumes of all petroleum compounds have great searching qualities, and therefore extreme precaution will have to be taken to guard the storage tanks. If it be true that for military purposes it is best in time of war to keep all reserve fuel afloat, then liquid fuel is at a disadvantage in this respect. The mining and railroad companies have invested so heavily in the coal industry and the transportation facilities have been so perfected that it is now possible to quickly deliver a cargo of coal at any point in the world. There has been, likewise, a development in the method of loading and unloading cargoes of coal. Since it will require progressive development to perfect the transportation and the storage of oil, and as the world's supply is still an unknown quantity, it will be some time before there may be a reserve supply of oil at the principal seaports.

"It must also be remembered, when considering the problem of supply, that the naval vessel must be kept in readiness for orders to proceed at any time to any port within her steaming radius. The merchant vessel steams to regular seaports, where it would not be difficult to induce merchants to keep a supply of oil as soon as there is a regular and constant demand for it. The question of oil supply for battleships and cruisers may therefore be not only a commercial affair, but prove to be a military problem, since the oil requirements of naval vessels for service conditions might only be met by the government establishing oil-fuel stations. The military aspect of the establishment of fuel stations may prove to be a serious problem, since it may not only necessitate heavy expenditures, but may involve the greater political question as to the wisdom of maintaining a complete chain of fuel stations between country and colony."

The more carefully, however, the structural problem as regards a fuel installation on a battleship is considered, the more difficult and complicated appears its solution. The storage of oil fuel on board the armored cruiser or battleship, or what might be termed the structural feature of the problem, is thus undoubtedly the great deterrent to the use of what may popularly be regarded as an incomparable fuel for warship purposes.

In the warship, the oil fuel will probably have to be carried below the protective deck; in fact, as far below the water line as possible. In the merchant service the tanks often rise to the height of the main deck. In the warship, however, considerable space must be found in the lower portions of the vessel for the storage of ammunition and ship's equipment, thus rendering it exceedingly difficult to secure beneath the protective deck sufficient space for the storage of the oil supply.

Crude oil is a greater searcher, and unusual care will have to be exercised in the construction of tanks or receptacles on board warships for the stowing of such fuel. Some of the resulting gases from the volatilization of liquid fuel are not only poisonous but explosive, and being much heavier than air, their removal from the storage tanks will be a very difficult matter.

Not only will it be necessary to increase the number of fuel compartments if oil is substituted for coal, but greater care will have to be exercised in making the bulkheads tight. In order to increase the safety of such vessels it would be essential to have the various oil compartments absolutely distinct from each other.

In the loading and unloading of oil-carrying steamers, fires are always hauled from the galleys and boilers of the vessels. On board the warship, where a large crew has to be housed, the putting out of the galley fires would subject the crew to much inconvenience. The modern warship is now crowded with so many auxiliaries, that steam must be maintained in some of the boilers of naval vessels at all times, and therefore the dangers attendant upon the stowage of oil in warships will be much greater than that in merchant vessels.

Hence, that if oil fuel is ever used on board warships, it will be essential to make the containing walls of the oil tanks much heavier than in the case of the ordinary water-tight bulkhead. The formation of heavy gases that will accumulate as the amount of liquid fuel decreases will constitute a great danger. The more the tanks are depleted the greater will be the danger from a possible explosion. The general structural arrangement of the battleship even now is of such character that the satisfactory ventilation of every compartment has not been secured, and particularly will such be the case where the fuel supply is of oil rather than of coal.

In all probability the great bulk of the oil in the warship would have to be kept in the double bottoms. As the petroleum vapors are quite heavy, it may be a difficult matter to free these compartment of explosive gases, especially when the compartments are partly empty. By reason of the great number of electrical appliances in use on board the warship hundreds of sparks are likely to be caused, any one of which might cause an explosion and set the oil fuel on fire.

In submarine boats no effective way of rapidly removing the noxious and explosive hydrocarbon gases from the gasoline engines has yet been devised, although the hulls of such boats are simple spindles with a large opening or conning tower in the center. Experience with gasoline vapors in this class of naval construction will give some idea of overcoming the greater problem of removing gases from the numerous small compartments of a battleship. The difficulty of freeing the compartments of the heavy and explosive gases is almost a problem within itself, and will require extended investigation and experiment before any naval power seriously considers the proposition of installing an oil-fuel system exclusively on board a warship.

With oil as a fuel it will be essential to provide a very complex installation of piping. It may be necessary to make arrangements whereby live steam can be admitted to each compartment for the purpose of putting out fires and also for the removal of the heavy gases. The condensed water resulting from this steam will have to be removed to prevent corrosion of bulkheads. Experience may also show the necessity of having a system of piping whereby the oil compartments could be flooded. Exceeding care will have to be used in making all joints, for if any leakage should reach the bilge and if the oil should then rise through the flooding of the bilges to the level of the fireroom plates the safety of the vessel might be endangered.

In the case of passenger and freight steamers, the vessels are of sufficient length to permit the main supply of oil to be carried in an expansion trunk or bunker extending the full width of the ship. It is also possible to have a cofferdam both forward and aft of this bunker, and thus leakage is quickly detected before such leakage has a chance to reach the double bottoms under the firerooms.

For naval installations there should be supplied a fuel that will not flash under 175 deg. F. The higher flash point required for naval than for merchant vessels is essential for the following reasons:

(a) The war vessels must be kept in readiness to proceed to the Tropics at immediate notice, and the firing of the guns subjects the naval ship to danger conditions to which other types of vessels are not exposed.

(b) The fitting of numerous transverse bulkheads and a protective deck in a naval installation, combined with the fact that both machinery and boilers are exceedingly crowded, makes it extremely difficult to properly ventilate certain compartments, and therefore in warships it will be necessary to use special precautions both in the stowing and in the handling of oil fuel.

(c) The fact that a large number of men must be permanently housed beneath the decks on the naval ships will make it difficult to prevent the use of open lights in some of the lower compartments, and thus the danger of using oil as a fuel from this cause will always be greatest in naval vessels.

Conclusions.

In closing this review I may say that I regard the engineering or mechanical feature of the liquid-fuel problem as having been practically and satisfactorily solved. For manufacturing purposes the financial and supply features are the only hindrances to the use of crude petroleum as a standard fuel. For mercantile purposes the commercial and transportation features of the problem are existing bars which limit the use of oil fuel in merchant ships. For naval purposes there is the additional and serious difficulty to be overcome of providing a satisfactory and safe structural arrangement for carrying an adequate bunker supply.

While my discussion of this subject has, perhaps, exceeded the limits assigned for a paper to be presented before the International Congress, I feel, in view of the growing importance of this matter, and of the high character and completeness of the researches made recently, under my direction, by the Liquid Fuel Board of the United States navy, that this essentially brief and general review may have sufficient value to warrant its necessary length.

Condensation Nuclei.—C. Barus has pursued his investigations of condensation nuclei in the atmosphere, and has elucidated the relations between them and ions. The latter are much larger. The nuclei studied by the author are of molecular dimensions, and exist in air by the million per cubic centimeter instead of by the hundred, like the ions. He calls the nuclei "colloidal air molecules." In moist air the nuclei are perpetually regenerated. Their generation is greatly aided by γ-rays of radium. When the nuclei are precipitated and the water is evaporated the nuclei do not, like a solute, remain behind, but evaporate with the water, and are then ready to act again. In this manner they differ from ions. Röntgen rays are powerful producers of nuclei. Their action in this respect is not confined to their immediate path, but extends much further. Nor does the law of inverse squares apply to this action, for at distances where the fluorescent screen ceases to show any action the production of nuclei is but slightly weakened. The interposition of lead screens reduces the action to a certain minimum—say, 1 per cent—but this minimum cannot be further reduced by interposing a lead screen many centimeters thick. For the γ-rays of radium this minimum is much higher. The author photographs fog by precipitating the droplets on a film of sticky oil.—C. Barus, Physikalische Zeitschrift, October 26, 1905.

SIMPLE TRANSFORMER FOR AMATEUR USE.*

By EDMUND S. SMITH.

For experimental purposes, it is often desirable to have at hand an alternating current of low voltage. Such a current may be used quite as satisfactorily as direct current for many purposes, and when it is possible to secure it without the trouble and expense incident to batteries, the alternating current is not only cheaper but more convenient. It may be used for heating or fusing wire, lighting small incandescent lamps now so commonly used for decorative purposes, or even for operating small direct-current motors, such as those used on miniature electric railways, the supply being drawn from the 100-110-volt lighting circuit now so readily obtainable.

To secure this lower voltage, a transformer furnishes by far the most efficient means. It is the purpose of this article to describe a small transformer that anyone at all familiar with tools can easily build. The total cost of materials should not exceed three and a half dollars, while the only machine tool necessary is a small drill press.

The capacity of the transformer here described is approximately 100 watts. It is designed to translate the usual 100-110-volt alternating-current lighting circuit to 10 volts or less on a frequency of 25 cycles per second. Data will be given, however, for the higher frequencies which are often found on incandescent lighting circuits, the design being the same in all cases with differences mainly dimensional. A method will also be given by means of which the secondary, or induced, electro-motive force may be varied from one-half volt to 10 volts by steps of about one-half volt each. This range is secured by properly placed taps in the secondary winding, and is much superior to the regulation obtainable by resistance methods.

The first part to be considered in the construction of the transformer is the magnetic circuit, or core, interlinking the primary and secondary windings. For a frequency of 25 cycles, the author used a cross-section of nearly 3½ square inches, though for higher frequencies this may be materially reduced.

COMPLETED TRANSFORMER.

Scale: 1 inch = 10 inches.

The core is made up of thin sheet iron strips of the dimensions shown in Fig. 1. These strips should not be much more than 0.02 inch thick, while still thinner iron would be better. To secure these strips most readily, order from any hardware store or tinsmith 80 pieces of light black sheet iron (stove-pipe iron will do) 1½ inches wide and 24 inches long. The iron is sold in sheets 24 inches wide, and the dealer will cut these strips the width of the sheet for a small extra charge. These long strips are then cut into an equal number of 4¾- and 3-inch lengths with tinner's shears. To facilitate this operation, a cutter and gage is readily improvised by mounting one arm of the shears in a vise so that the cutting edge is horizontal and about 4 inches above the work-bench. Place a piece of 2-inch by 4-inch timber about 2 feet long on edge on the bench at right angles to the shears, with one end nearly touching the cutter. A few wire nails carefully placed along the upper face serve as guides to keep the strip perpendicular to the cutter as it is fed forward between the blades. A block of wood clamped to the bench on the opposite side of the vise serves as a gage, determining the length of strip pushed through the shears, the strip being fed forward until it meets the wooden block. It is then cut and the operation repeated. To avoid changing the gage, it is best to cut three 4¾-inch lengths from all the long strips; then, changing the gage to 3-inch, repeat the cuts on the shortened strips.

There will now be two hundred and forty strips of

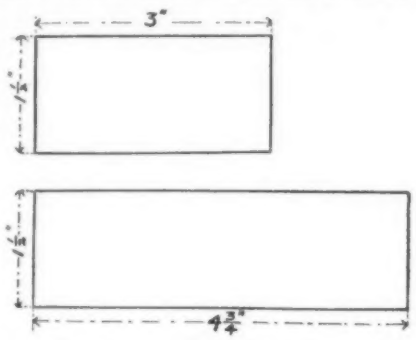


FIG. 1.—SOFT IRON STRIPS 0.02 INCH THICK. HALF SCALE.

each size. Take half of the longer strips and begin building up a pile, placing each strip directly upon the one below, but with its end overlapping it 1½ inches, the next overlapping this 1½ inches at the opposite end, and so on until one hundred and twenty strips are in place. Fig. 2 shows the strips properly arranged, and also location of the rivet holes which are to be drilled. When tightly clamped, as described below, this number will make a pile about 2¼ inches high. If slightly thinner or thicker strips are used, a greater or less number should be taken, in order to bring the compressed pile to about this thickness, so that sufficient cross-section of iron is insured. This arrangement leaves a series of slots at each end, into which later are slipped the shorter pieces forming the yokes, affording a very good magnetic joint. The pile is now clamped between two short pieces of bar iron and drawn together by four 5/16-inch bolts. If more convenient, this clamp may be made from maple or other hard wood, but in this case it will have to be made considerably heavier to withstand the strain. Before tightening on these bolts as far as possible, the ends and sides of the pile are squared up even with a light hammer. One face of the clamp has three ¾-inch holes drilled through it, and these are countersunk with a 7/16-inch drill *almost* through, as shown in Fig. 3, which illustrates the arrangement and proper spacing of these holes. Now draw the bolts up as far as possible, and drill the strips through these three holes with a 3/16-inch drill. Remove the clamp carefully, and slip through each hole a ⅛-inch rivet. A heavy wire nail cut to the proper length will serve the purpose, the head being placed on the lower side. To avoid local heating due to eddy currents at these rivets, it is best to wind them with linen tape to fill the 3/16-inch hole. The clamp is then replaced and again drawn tight. About 1/16 inch of the rivets should now project into the countersunk hole in the upper clamp. These may be peined over with a small hammer working in the countersunk hole. This insures the strips being bound closely together and held so permanently after the clamp is removed.

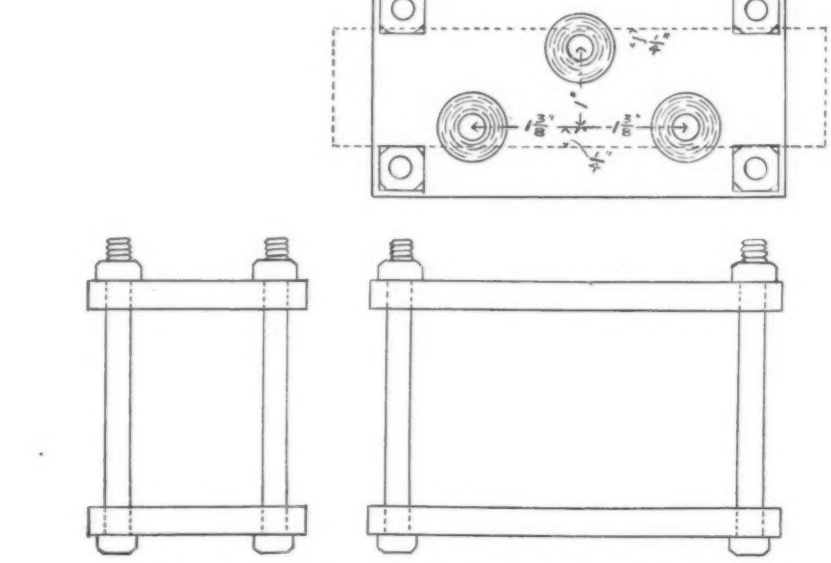


FIG. 3.—DRILLING CLAMP. PLAN, ELEVATION AND END VIEW. HALF SCALE.

The remaining set of longer strips is treated in exactly the same manner, care being taken that they are drawn to the same thickness in the clamp when ready for riveting as the first lot. The shorter strips need not be riveted, as will appear later. From ⅛-inch fiber cut four washers as shown in Fig. 4. These serve as heads for the winding. They should be made a tight fit, and are now driven on the riveted strips, two washers to each bundle, leaving 1½ inches clear at each end, with 3 inches between them. Wrap the cores with three layers of linen tape, coating each layer with shellac. Wind the tape well up to the fiber heads, so that no iron is left bare. Place the cores in an oven over night to harden the shellac. After baking, the cores are ready for the winding of the primary coils.

The number of turns of wire necessary is found by the following formula:

$$T = \frac{E \times 10^8}{4.44 \times N \times B \times A}$$

in which

T = total turns of wire in series.
E = electromotive force in volts.
N = frequency in cycles per second.
B = lines of force per square inch.
A = section of magnetic circuit in square inches.

In the present case, E is 100, N is 25, B is assumed to be 40,000, and A is 3.375. Since the actual cross-section is somewhat less than 3⅜ square inches, owing to some air spaces between the strips, it is safer to assume its value to be 95 per cent of the apparent section, or 3.21 square inches.

Substituting these values in the formula, $T = 709$ turns (approximately).

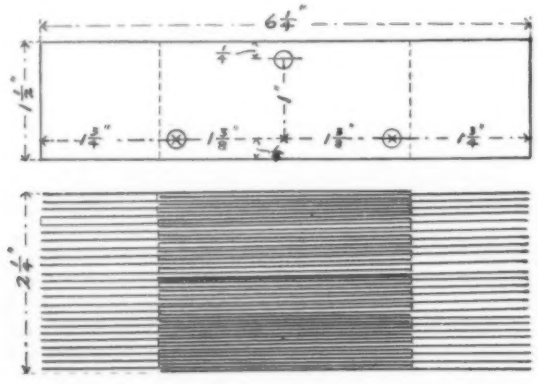


FIG. 2.—PLAN AND ELEVATION OF ASSEMBLED STRIPS. HALF SCALE.

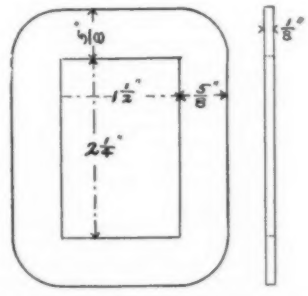


FIG. 4.—FIBER HEAD. HALF SCALE.

With an impressed E. M. F. of 100 volts and an output of 100 watts, the primary amperes would be one. No. 20 B. & S. wire will carry this current safely. It should be double cotton-covered, which gives it a diameter of 0.042 inch over the insulation. Since the distance between the fiber heads is 3 inches, each layer will contain about 70 turns, requiring therefore ten layers for the total wire. This is divided equally between the two coils, making five layers on each coil.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

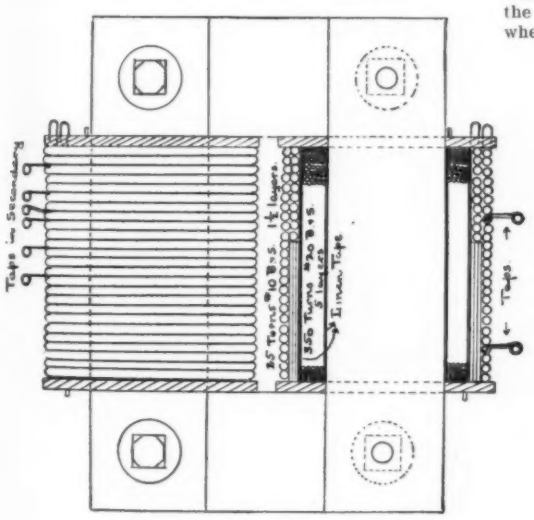
Wind the wire on evenly, coating each layer with shellac as completed. The starting and finishing ends of the wire are brought through small holes drilled in the fiber heads, leaving about a foot or more of wire at each end for the connections to be made under the base.

The coils must now be carefully wound with three layers of linen tape, well shellacked, and again baked as before.

At 10 volts the secondary current will be 10 amperes and the number of turns one-tenth that in the primary winding, or 70, each coil therefore taking 35 turns. To carry this current without overheating, No. 10 B. & S. wire is necessary. Double cotton-covered, about 25 turns of this size wire can be wound in a 3-inch space. It is best to wind 10 turns on top of the insulation over the primary in one layer, and fill out the remaining space with cardboard or tape to a height equal to the wire. Then place the remaining twenty-five turns over this, thus giving a smoother and more finished appearance to the outside coils.

During the winding of the secondary coils, the taps should be placed in position. These taps are thin pieces of copper about ½ inch wide, the ends of which are rolled around the secondary wire and soldered. (See Fig. 5.) There are eight of these taps placed as follows: One each on the fourteenth, twenty-eighth, forty-second, and fifty-sixth turn (i. e., one every fourteenth turn) and then one each on the fifty-ninth, sixty-second, sixty-fifth, and sixty-eighth turn (i. e., one every third turn). This will bring two taps on one coil and six on the other. All should be placed on one side of each coil, preferably on the wider face. Since the three-turn taps are quite close together, it is best to stagger these, placing alternate taps in a line an inch or so below the one immediately preceding. Leave about ¾ inch of the copper strip projecting from the wire, as the leads to the switch-points are to be soldered to these strips later. When the winding is completed, with the taps in place, shellac and bake the coils as before.

Now stand the two finished cores on end, with a space just 1½ inches between them. Insert one 3-inch strip, edge first, into one slot. It will exactly fill the slot, and extend to the inner face of the other core-piece. Then put another strip into the adjacent slot of this latter core, extending to the inner face of the first core, and so on, inserting strips first in one core slot and then in the other, until every slot is filled. This end or yoke will have, therefore, exactly the same tongues and slots when assembled as the core pieces illustrated in Fig. 2. When one pair of ends are completely yoked, invert the cores and place the remaining strips across the other ends. Clamp the corners tightly, and drill a 5-16-inch hole through each of the four corners. Place ¼-inch bolts, wrapped, like the rivets, with tape in these holes, and draw the nuts down hard on the washers.



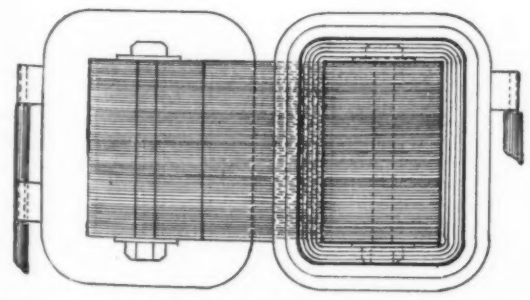


FIG. 5.—PLAN AND ELEVATION OF COMPLETED TRANSFORMER, SHOWING ARRANGEMENT OF WINDING AND INSULATION.

The transformer is now completed, and ready to be connected to the regulating switches. Fig. 5 shows the plan and elevation of the transformer, one coil as it appears when completed, the other coil showing in section.

The regulating switches, two in number, are most conveniently mounted on a hardwood base, together with the transformer, fuse-blocks, and plug socket. The base measures about 15 inches by 7 inches by ¾ inch. Strips of wood ⅝-inch square are screwed to one face along the four edges, the corners being mitered. These strips furnish a recess under the board which readily contains all the connections.

The switches are mounted at one end, as shown in the photograph. The contact points and arms may be purchased for a small sum, or may be easily made from sheet brass or copper. Take a flat piece of copper 1/16 inch thick, and mark out ten pieces the size and shape shown in Fig. 6. Saw these out with a hack-saw, and finish with a file. Drill two holes in each piece, and countersink same for a small flat-head screw. One of these may be a ½-inch brass wood-screw, while the other is a No. 6 flat-head brass bolt 1 inch long with nut, which, passing through the base, affords an easy means of connecting the leads from the transformer to the switch points. The arm is a piece of brass or copper pivoted on a round-head brass bolt, working on a washer exactly the same thickness as the switch points. Care must be taken that the points and this washer are all exactly in line, so that the arm will make good contact with each point. Fig. 7 shows the plan and sectional view of one switch and arm when mounted. There are five points to each switch, as shown in Fig. 8. The switch *A* is so connected that each step cuts in or out fourteen turns of the secondary winding, thus increasing or decreasing the secondary E. M. F. about two volts. The points of switch *B* are connected to the taps from the last fourteen turns of the secondary, one to every third turn, so that each step on this switch represents 3-14 of two volts, or practically one-half volt.

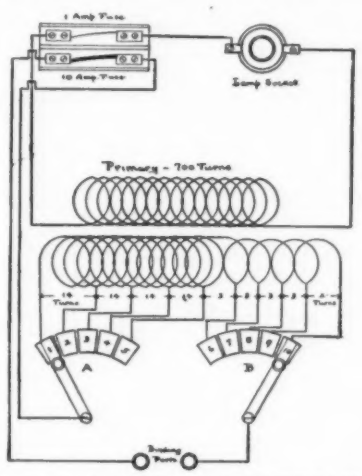


FIG. 8.—PRIMARY AND SECONDARY CONNECTIONS.

Thus by proper adjustment of the two switch arms, it is possible to secure any voltage from ½ to 10 volts by ½ volt steps. For example, with the switch arms on points 1 and 10, as illustrated, the maximum voltage is obtained. If one arm were on point 1 and the other on point 6, the voltage would be practically 8½. If points 3 and 8 were in contact with the switch arm, the voltage would be 5½, etc. Points 5 and 6 yield but ½ volt, the lowest obtainable with these connections.

The connections from the transformer taps to the switch points are shown in Fig. 8. The primary coils are connected in series, as are also the two coils of the secondary. One leg of both primary and secondary circuit should be protected by a 1-ampere and 10-ampere fuse respectively.

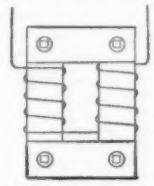


FIG. 9.—PRIMARY COILS CONNECTED IN SERIES.

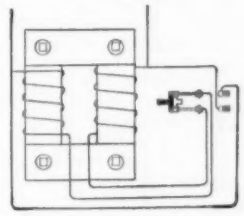
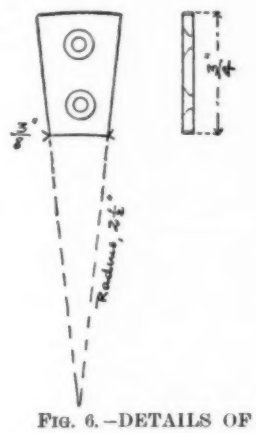


FIG. 10.—PRIMARY COILS CONNECTED IN SERIES OR PARALLEL BY MEANS OF A DOUBLE-POLE SWITCH.

The leads from the copper strips on the secondary coils to the switch points should be made with wire at least as heavy as No. 14 B. & S. Holes are drilled in the base directly under each tap, through which the wire passes. A similar method is used for the primary wires, so that all connections may be made under the base. Use heavily insulated wire, protecting all wires that cross with a few layers of tape.

In case the transformer is to be operated on circuits having a higher frequency than 25 cycles, the cross-section of core may be materially reduced while the number of turns of wire is increased.



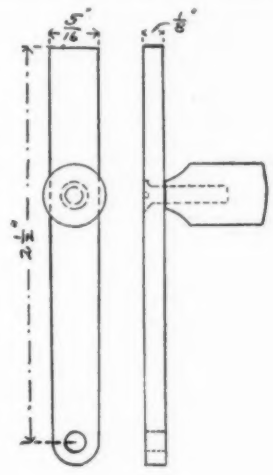
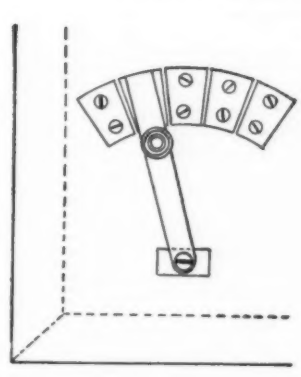


FIG. 6.—DETAILS OF SWITCHES. FULL SCALE.



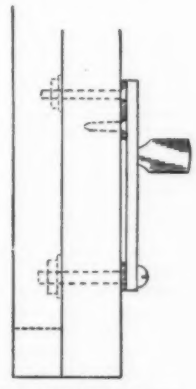


FIG. 7.—PLAN AND SECTION OF SWITCH MOUNTED ON BASE. HALF SCALE.

For a frequency of 60 cycles per second, the sectional area of the core should be about 1½ square inches, conveniently obtained by using sheet-iron strips 1¼ inch wide, enough being taken to make a pile 1¼ inch high, in this case giving a square section to the core. The core strips will measure 4½ inches long, and the yoke strips 2¾ inches long. The winding consists of 1,000 turns of No. 20 B. & S. wire on the primary and 100 turns of No. 10 wire on the secondary. If the

same arrangement of secondary taps as described above is desired, these taps will be placed on the twentieth, fortieth, sixtieth, and eightieth turns for the two-volt steps, while the ½-volt taps are placed on the eighty-fourth, eighty-eighth, ninety-second, and ninety-sixth turns.

For a frequency of 125 cycles, the areas of the core need be but one square inch. In this case, the sheet-iron strips would measure 4¼ inches long by 1 inch wide for the core-pieces, and 2½ inches long by 1 inch wide for the yokes, enough being taken to make a pile one inch high when compressed. The winding is the same as in the case of 60 cycles. This amount of wire with its insulation occupies a space of about ⅝-inch in height, so that the fiber washers may be cut to leave a margin of ⅝ inch on all sides of the central aperture.

In connecting the two coils of the primary, it is just as necessary that these be in series as in the case of two or more coils on a direct-current motor or dynamo. Fig. 9 shows the direction in which the winding should be connected. It makes no difference which is the starting or the finishing ends of the coil, so long as the ends are connected to secure the direction of winding shown. This same plan applies to the two secondary coils.

If a secondary E. M. F. of more than 10 volts is desired, it is readily obtained by the use of an additional switch. To secure this higher voltage, connect the coils as shown in Fig. 10. By means of the double-pole, double-throw knife switch illustrated, the primary coils are put either in series or in parallel as desired. The parallel connection divides the current equally between the two coils, so that the E. M. F. of *each* coil is 100-110 volts. The ratio of primary to secondary terms is thus decreased from 10:1 to 10:2, the result being a maximum of 20 volts in the secondary, and each step in the regulating switches just doubled. The range in voltage therefore will be from 1 to 20 volts, by steps of 4 volts and 1 volt on switches *A* and *B* respectively.

It is probable that the coils will heat up somewhat if kept too long connected in this way, owing to the fact that the magnetic flux density is thereby doubled, but with the intermittent load usually used in experimental work, this effect will hardly be appreciable.

SIMPLE EXPERIMENTS WITH CURRENTS OF HIGH TENSION AND FREQUENCY.*

By THOMAS R. HOPPER.

IT is a well-known fact that the discharge of a Leyden jar or condenser is not a single flow of current in one direction, but a number of reflex actions or oscillations forward and backward until equilibrium is established. Taking into consideration the extremely small space of time occupied by the discharge, the frequency of the oscillations or alternations must be very great, but this frequency can be varied within wide limits by varying the area of the inductive surface of the condenser, or by placing resistance or impedance in the discharge circuit. These high-potential alternations disturb the medium surrounding them, and if the discharge is passed through a coil composed of a few turns of coarse wire, the radiations emanating from the same will give rise to currents of high tension and frequency in an adjacent coil composed of a greater number of turns of finer wire, and these induced currents are possessed of many peculiar characteristics which readily lend themselves to experiment.

The cross section of a simple high-frequency coil is shown in Fig. 1. The heads, *a a a a*, are circular collars of wood 10 inches in diameter by ¼ inch in thickness, with a round central opening 6 inches across. Around the heads should be secured a sheet of moderately thick veneer or heavy cardboard, *d d*, 1 foot in width and about 31½ inches long, forming a tight drum. Upon the outside of the drum should be wound twenty-five turns of three No. 10 bare copper wires laid in parallel, and the convolutions evenly spaced, so that each does not come in contact with its neighbor. It will be found convenient to wind one wire at a time, and soft-drawn copper should be employed. The three wires should be soldered together at each terminal, to insure each separate wire carrying its proportion of the current. This forms the primary coil.

The secondary coil consists of No. 36 silk-covered copper wire wound the full length of a Bristol board cylinder, *b b*, 6 inches in diameter and 1 foot long. For convenience in winding it is best to fit the cylinder with two temporary wood heads, so that it can be chucked in the lathe, and remove them when finished. The wire should then be given a liberal coat of shellac varnish, using care to work it well into the insulation. After drying, the wound cylinder should be placed through the openings in the heads in the center of the drum, the terminal wires projecting for connection. This completes the high-frequency coil.

For the inductive surfaces of the condenser sixteen sheets of tinfoil 5 by 10 inches will be necessary, and for the dielectric double that number of paraffined paper sheets 7 by 12 inches. Upon a piece of stout cardboard of the same size lay two sheets of paraffined paper, and upon these a single sheet of foil, one inch of which should be left projecting to the right for connection. Upon this place two more sheets of paraffined paper and a second sheet of foil with an inch margin projecting to the left. In this manner continue until all material is used, each alternate sheet of foil projecting to the right and those between to the left, and each separated from its neighbor by two thicknesses of paraffined paper. This will leave eight marginal edges of foil at each end for connection.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

To charge the condenser and energize the high-frequency coil, an induction coil capable of throwing from a 2 to 4 inch spark will be necessary. The method of connecting the apparatus is shown in Fig. 2. The primary circuit of the induction coil, *i*, is represented by the two wires, *p p*. Bridged across the secondary circuit, *s s*, is the condenser, *c*, which discharges itself across the spark gap, *a*, and through the primary, *d*, of the high-frequency coil. The secondary circuit and terminals of the latter are shown at *b*. The spark gap,

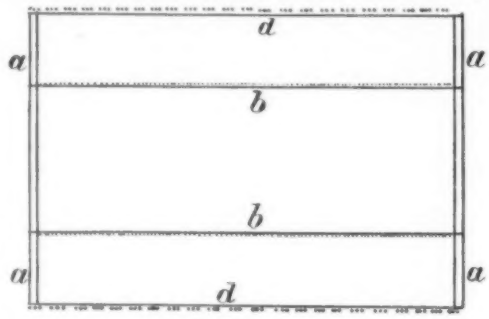


FIG. 1.

a, should be between two brass balls about ½ inch in diameter, and should be arranged so that their proximity can be varied. When in working order they should be about 1/16 inch apart, and the discharge across them should give a *loud smooth* sound without any trace of shrillness. The surfaces of the balls should be kept well polished.

Probably one of the most surprising features of the high-frequency currents is the ease with which they penetrate well-known insulators. If one side of a sheet of glass is coated with foil, and the latter attached to one terminal of the high-frequency coil, upon bringing the remaining terminal in close proximity to the clean side, the spark will break into innumerable ramifications, spreading over its surface, and if continued for a short time the glass will become slightly heated by the impact. If the outer and inner coatings of a Leyden jar are each attached to opposite terminals, it will be found that the coil is practically short-circuited through the dielectric. In the same manner sparks may be drawn through the glass bulb of an incandescent lamp by bringing the metal tip in contact with one terminal, and approaching a bit of metal to the outside surface of the globe. Hard rubber, fiber, etc., present but little hindrance to the current, and it will be found by experiment that oils are the only substances that can be relied upon for insulation.

If the current is allowed to pass through the body of the experimenter by grasping the terminal in the hands, a shock will be the result; but if a small Leyden jar is included in the circuit, the current passing from one coating to the other through the glass, there will be but little sensation, and in this manner sparks several inches in length can be taken through the body without inconvenience.

As the current is vibrating at a great frequency, it readily produces some very powerful brush effects. This is easily shown by attaching one end of five or ten feet of No. 36 cotton or silk covered copper wire to one terminal of the coil, and the opposite end to an insulated support, leaving the wire hanging clear. Upon touching the remaining terminal with a bit of metal held in the hand, the wire will break forth into numberless streams or threads of light palpitating in

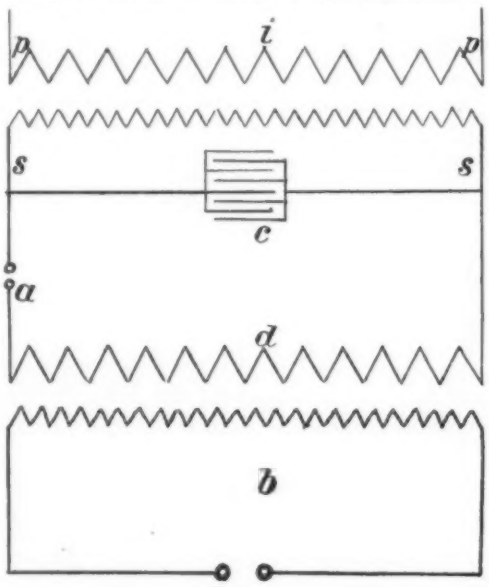


FIG. 2.

unison with the discharge of the condenser. This experiment also demonstrates the influence of the addition of capacity to the coil. It counteracts the self-induction, and thereby increases the current. A simple experiment exemplifying this same point is as follows: Stretch out a piece of No. 36 covered copper wire about 25 feet in length, one end being attached to one terminal and the other to the metal tip of an incandescent lamp or vacuum tube. When the coil is energized, the lamp shows no effect at first; but if the operator's person or other body of like size is brought into contact with the remaining terminal of the coil, the lamp will glow, showing the passage of energy. Another simple method of illustrating the brush effect is by an experiment performed by Mr. Tesla. Two circles of No. 18 bare copper wire 8 and 12 inches in diameter respectively should be constructed and mounted concentrically, one within the other, in the same plane. They have no connection with each other, but each is attached to one terminal of the coil. When in action the space between the wires is uniformly filled with fine streams or luminous threads, forming an illuminated disk or collar.

If one of the terminals is grounded, the coil will be left out of balance, so to speak, and if the operator's body, insulated from the earth, is brought into contact with the remaining terminal, the coil in effort to equalize itself will give rise to luminosity in an incandescent lamp globe or vacuum tube grasped by its metal tip. The bulb will continue to glow, no matter in what position it is held, and if waved back and forth a multiplicity of images result, due to the intermittent discharge of the condenser.

A simple and gratifying experiment is that of conversion on *open* circuit. For this purpose it will be necessary to construct a second high-frequency coil exactly duplicating the first. Connection should be established from one terminal of the secondary of the first coil to one terminal of that of the second, and the two remaining secondary terminals of both should be connected to separate metal sheets of several square feet surface. This leaves but one connection between the two coils and no return wire, consequently there is not a complete circuit. When in action enough energy passes to induce currents in the primary of the second coil of sufficient power to light a small half-candle-power incandescent lamp.

Many simple and instructive experiments, of which the above are a few examples, can be performed with this inexpensive apparatus.

CONTEMPORARY ELECTRICAL SCIENCE.*

THE SPINTHARISCOPE.—The scintillations of phosphorescent zinc sulphide, when subjected to the bombardment of the radium corpuscles, has not yet been satisfactorily explained. Crookes regards each flash as due to the impact of a single positive ion or *a*-particle, while Becquerel regards the production of light as a secondary effect resulting from cleavages of the crystals brought about by the action of the rays. These two views are not entirely incompatible, but R. W. Wood has obtained some data which, though not very conclusive, make it probable that Becquerel's triboluminescence is not the process actually in operation. He judges by the duration of the flashes. When zinc sulphide is mounted on the rim of a rapidly revolving disk, exposed to radium, and viewed through a small lens, the flashes are not drawn out until the disk is made to revolve at a very great rate. Their duration is hardly more than 1/20,000 of a second. When the sulphide is touched with the point of a glass rod, thus producing cleavages, the flashes apparently extend halfway round the disk. The author also tried photographic records of the scintillations, and found after an exposure of several days that only certain points of the sulphide screen were affected. He believes the flashes are conditional upon the presence of some impurity, and that only a small proportion of the sulphide crystals contain this impurity. In any case, the flash is not instantaneous, and its wave-train is several miles in length.—R. W. Wood, Philosophical Magazine, October, 1905.

THEORY OF MAGNETISM.—P. Langevin works out the electron theory of magnetism. He starts from the conception of electrons revolving in orbits about atoms, and constituting amperean molecular currents or Ewing's elementary magnets. He shows mathematically that the establishment of a magnetic field modifies the molecular currents, as Weber supposed fifty years ago, and as is known to take place in the Zeeman effect. This modification or change of period is very slight, as is also the Zeeman effect, but it is always in the diamagnetic sense, and independent of the temperature or state of aggregation of the body. Diamagnetism is thus fully explained, and is the fundamental phenomenon. All matter is essentially diamagnetic, and paramagnetism and ferromagnetism are only superposed effects, the first being due to the orientation of the molecular magnets in accordance with the external field, and the second being due to the mutual influences of the molecular magnets. As soon as paramagnetism appears, it is large compared with diamagnetism, and completely masks it. It can be shown by the equations of Maxwell and Hertz that the magnetic moment of a molecular current is increased by a field *H* normal to its orbit by the amount

$$\frac{He^2S}{4nm}$$

where *S* is the area of the orbit. But the strongest field we can produce is less than 10^3 units, and we are therefore unable to change the molecular magnetic moment by more than 1-100 of 1 per cent. Hence the smallness of diamagnetic polarity and of the Zeeman effect. The author further shows that the molecular current will accurately represent Weber's circuit of zero resistance if the inertia of the electron is entirely electromagnetic. Since the diamagnetic modification is very slight, the molecular currents may be consid-

* Compiled by E. E. Fournier d'Albe in the Electrician.

ered as indeformable and as constant in strength. This implies that a complete representation of the facts of paramagnetism and of the exchange of energy between magnets and currents is obtained on the hypothesis that the magnets consist of similar currents rigidly obeying the ordinary laws of electrodynamics. As regards paramagnetism, Curie has shown that paramagnetic susceptibility is inversely proportional to the absolute temperature. The author fully explains this law. The molecules whose magnetic axis is parallel to the field acquire a greater kinetic energy than the others, leading to an increase of temperature proportional to the increase of moment. To reduce this a quantity of heat $dQ = H\,dM$ must be abstracted. Since $\frac{dQ}{T}$ is an exact differential, we have Curie's law

$$M = k\frac{H}{T}$$

if the magnetization is proportional to the field.—P. Langevin, Journal de Physique, October, 1905.

SOLUTIONS OF SOLIDS AND SOLID SOLUTIONS.*

By J. H. STANSBIE, B.Sc., F.I.C.

THE general question of solution has always been of importance to the metallurgist, and is becoming more so on account of the fresh information concerning the nature of solutions which is constantly coming to hand. The practical metallurgist has so many difficulties to overcome in the melting, casting, and manipulation of metals and alloys generally, that information which seems to have but a remote bearing upon his work may prove useful, and he cannot afford to let it pass.

Solids and liquids are recognized by their general properties, and it is certain that whatever matter is, a solid body of appreciable size is made up of parts, and that there are causes within the body which determine the relative positions of these parts, and also their mean distance apart. This may be explained by assuming that internal friction prevents the separation of the parts, or that there is a constantly acting pressure which is directed toward the interior of the solid. The idea of internal friction is supported by the viscosity of the malleable metals, which enables them to flow under the hammer. But in order that this change in form may take place, work must be done upon the metal, and in this respect the viscous solid differs from the true liquid, which can alter its form without expenditure of work, if allowed to do so. It will be well to keep this viscosity of metals in mind, and to remember that for the majority of metals there is a temperature at which the metal offers the least resistance to work done on it while still preserving the solid state.

Also, it may be noted that the work put on to a solid during its change of form may all be converted into heat, or part of it may be stored up in the body itself. The latter is the case with metals which harden when they are worked, and the fraction of the energy thus stored up is given out again during annealing. Thus the system "hard metal" contains more energy than the system "soft metal."

Generally speaking, the particles of a solid are under restraint, and their separate motions are confined to excessively small spaces; but in a liquid there seems to be nothing to quite hinder its particles from wandering anywhere within the boundaries of its volume. There is, however, a cause which determines the mean distance of these particles, and so determines the volume of the liquid. It is well known that an enormous pressure is required to reduce the volume of a solid or liquid when it is a true volume pressure—that is, directed from all parts toward the center of the body; although the density of a metal may be increased by working.

Now we may regard any solid or liquid body as a self-contained system which will conserve itself as long as neither matter nor energy crosses its boundary, although the relations between its matter and energy may undergo readjustment. But if energy enters or leaves such a material system, important changes may take place. The changes we have to consider refer to the solid and liquid states.

Solids may be divided into two classes—amorphous and crystalline. Amorphous means without form, in the sense of without crystalline form. Amorphous solids seem to come more into a line with liquids. They certainly resemble ordinary liquids in viscosity, although their viscosity is much greater than that of water. There is a tendency to wander on the part of the individual particles; but whether it takes place at ordinary temperatures, even to a limited extent, is an open question. Although Ewing and Rosenhain and Stead have observed the gradual absorption of one solid body by another, such solids have the same properties in all directions; that is, the forces at work within them are evenly distributed, and wandering is thus probable; for any slight disturbance of the equilibrium in any part would tend to set up motion in that part. This inclines us to the belief that metals which become plastic on heating lose their crystalline character when in the plastic state, and those that harden on working also tend to become amorphous. In a crystalline solid, however, there is no haphazard arrangement of the particles. The form of the ultimate particles or molecules seems to condition the regular arrangement, and the regular, though not always uniform, distribution of the internal forces.

Now if we agree that an amorphous solid resembles a liquid, it must also resemble a liquid solution; and if it resembles a liquid solution, it must also resemble a solid solution. May it be said, then, that a solid solution is amorphous?

But it is possible for an amorphous solid to crystallize under proper conditions; it is also possible for a solid solution to crystallize. Is it still a solid solution after the crystallization has taken place? The answer to this is, that mixed crystals are regarded as solid solutions. What is the solution of a solid? If a solid combines with a liquid to form a homogeneous mass—that is, a mass of uniform concentration, which is still liquid—the whole mass is called a solution of the solid, and the components of the solution are known as the solvent and the solute. In such a mass there is a complete merging of the components without regard to that fixed ratio between them which is so characteristic of a true chemical merging. In the process of solution the solid disappears from sight, even when aided by the most powerful microscope, and the most careful analysis fails to detect any difference in composition of different parts of the solution.

From what has been said already it will be understood that a kind of internal pressure is acting toward the interior of a solid, so as to keep its mass intact without aid from outside. You may call this attraction, cohesion, tenacity, or give it any name you please, but the fact remains that an expenditure of energy is necessary to separate its particles.

In the liquid state the body is in a more unstable condition, for in many cases its exposed surface loses some of its matter under certain conditions; but even this depends upon the readiness with which the liquid becomes gas. But as it loses matter it also loses internal energy.

Now, in the case of liquids a small portion of their internal energy seems to concentrate itself very near to the boundaries of the body. This is known as superficial energy, and its amount depends upon the area of its surface, and the bodies with which it is in contact. It appears to act in a very thin stratum, and is known as surface tension. This surface energy always tends to a minimum, and seems to act as a kind of pressure toward the interior when it is allowed full play. This is seen in the case of rain drops, which are masses of water occupying volumes with the smallest possible areas under the conditions. Here the surface tension causes the boundary layer to act like an elastic skin, and to draw the matter into its volume of smallest area.

A homogeneous solid or liquid is said to be in a definite phase, and it is immaterial how many components there may be in the mass as long as it is homogeneous. Another idea of a phase is that it is a mass of uniform concentration, and when it consists of more than one component they are mechanically or physically separable.

A system consisting of one or more phases is said to be in true equilibrium when it remains constant under constant conditions of temperature, pressure, and concentration, and when a very small change in one of these variables causes a correspondingly small change in the system.

Now turn to a system consisting of a solid and a liquid which will dissolve it. If there is an excess of the solid, the point of saturation for a definite temperature cannot be exceeded, however long the solid and liquid phases are in contact with each other. The two variables here are the temperature and concentration.

Let us consider for a moment what is happening here. We know that the solid phase is passing into a liquid phase; and we know further that it is a purely physical or mechanical action, and that heat is being absorbed. Now it is purely a surface action. The particles of the solid are in contact with the particles on the surface of the liquid, and their proximity assists in some way, it may be by surface tension, the internal energy of the solid, which is always directed outward, and some of the solid particles find themselves in the liquid. But these particles still have a tendency toward their own, and although they have become migrating bodies, they sometimes migrate back, and an interchange may take place between the particles of the solid in the liquid, and those in the solid itself. This goes on till the point of saturation is reached, and then the rate of exchange of particles is the same in all directions, and we have a system consisting of a solid phase and a liquid phase in equilibrium. The solid phase consists of one component, and the liquid phase of two components, the liquid and the solid dissolved in it.

The rate at which a given solid dissolves in a given liquid depends upon a number of circumstances. Sometimes it is very rapid, and sometimes very slow. Also the rate at which the solid particles will diffuse through the mass of the solvent may vary considerably.

It may be remarked that the idea of interchange or dynamic equilibrium between the solid and liquid phases after saturation has been reached appears to be opposed to that of uniform concentration; but it may be said that this exchange takes place only in the surface layers, and is of a constantly counter-balancing character. The necessity of the idea is shown by the fact that large crystals in a saturated solution may grow on one face and dwindle on another to exactly the same amount, the total mass of the crystal keeping constant. This is probably due to slight differences in the concentration of the layers in contact with the faces, which causes a difference in the surface energy on the faces. But as these differences may be excessively small, the general concentration may be regarded as uniform. The general principle contained in this statement is of importance in connection with solid solutions. There is also the view that the crystals may have different solubilities in different directions.

The equilibrium of the system solid solution is at once disturbed by an increase or decrease in its temperature. The general effect of an increase in temperature is to cause more of the solute to pass into the solvent, and a decrease to bring about the opposite effect. But this is not uniformly true, for the solubility of some solids increases with the temperature up to a certain point, and decreases with a further increase in temperature.

A solid in solution possesses a definite pressure, which is called its solution pressure; this is no doubt largely instrumental in bringing about diffusion of the solid through the bulk of the liquid after dissolution. It is well known that a salt in solution raises the boiling point of the liquid, and this means simply that a given rise in temperature causes a smaller increase in the vapor pressure of the solvent when a solute is present than when it is absent. Also, the freezing point of the solution of a solid is lowered by the presence of the solid; the lowest temperature being obtained for a definite concentration, which, in the case of salts and water, gives the composition of the cryohydrate, and in the case of alloys, the eutectic mixture.

In many cases solutions can be cooled below their point of saturation without any of the solute separating in the solid state; but the system is in unstable equilibrium, and a small portion of the solid dropped into the solution causes partial solidification, with development of heat, to take place at once.

What is a solid solution? A solid mass containing two or more components of uniform concentration. In other words, it is a homogeneous mass containing constituents which are physically and mechanically separable as far as solidity permits. Here we have the possibility of variations in concentration with variations in temperature; also of conditions under which certain components are in equilibrium. But it is very evident that the investigations of such conditions are much more complicated than with solutions of solids. All changes in solid solutions must be necessarily slow.

The clear glasses are probably the best examples of solid solutions, for their composition may vary by infinitesimals from specimen to specimen. The readiness with which molten silicates dissolve either silica or basic oxides is well known, and also that the components may or may not be able to remain in solution when the molten mass solidifies. If they do remain in solution, then a solid solution results; but if not, a heterogeneous mass is obtained.

Mixed crystals are also examples of solid solutions. Such crystals are best studied with salts crystallized from aqueous solution, and the alums furnish good illustrations. It is quite easy to form mixtures of common alum and chrome alum in any proportions.

Now these solid solutions which partake of the nature of mixed crystals are of considerable importance from a metallurgical point of view. All metals are of crystalline nature, and many of their crystalline forms belong to the cubic system—that is, they are isomorphous, and, all other conditions being favorable, should form mixed crystals. Thus it may be stated generally that, in the case of pure alloys of metals, the solid solutions take the form of mixed crystals. Gold and silver alloys give the simplest cases of solid solution of metals of uniform concentration. This is brought out by the freezing curve, which for a series of gold-silver alloys falls uniformly from the freezing point of gold to that of silver.

It has been stated that solid solutions in the case of metals are heterogeneous, on account of the slow diffusion which takes place in the molten metals as compared with the solutions of solids in liquids. But it would appear that this is only a matter of time, for if the alloy is kept molten sufficiently long, uniform concentration may be attained, and then the slow motions of the components in the solution would favor the retention of uniform concentration in the alloy on freezing. But another aspect of the question arises when chemical compounds are formed between two metals, or a metal and a non-metal. In this case any solution must be formed by the dissolution of the compound in excess of the main mass of the metal. A case in point is found in the alloys of copper and arsenic. Now there is not the slightest doubt but that arsenide of copper is formed and dissolved in the molten alloy. Micro-examination of copper-arsenic alloys shows that a separation takes place during the solidification. But it is probable that a certain percentage of arsenic in the arsenide forms a solid solution, which has a much less hurtful effect on the main mass of the metal than when a eutectic separates. This is a practical question of some importance to those who introduce small percentages of certain elements into copper to produce sound castings. For it is clear that the proportion of the added element should be about that required to form the solid solution; and this for arsenic in copper seems to be about 0.25 per cent of arsenic.

The relations of carbon to iron in alloys of these bodies have formed the subject of an enormous amount of work, and many investigators are still at work upon it. The only reference I wish to make to that work is in connection with the solid solutions of carbon in iron which exists in hardened steel, and which is known by the name of "hardenite," about which the last word has not been said. Now, Howe states that solid solutions are heterogeneous, and probably bases his opinion upon a micro-examination of hardened steel; but is it necessary to assume this heterogeneous character from an etched specimen? A solid solution should etch uni-

* Abstract of paper read before the Metallurgical Society at the Birmingham Municipal Technical School.

formly, and that is the only condition necessary; for if an etching liquid is used, it attacks the component of the solid solution for which it has the greatest affinity.

OLD INVENTIONS.

By F. M. FELDHAUS.

WE need not despise modern inventions in order to accord full recognition to those of the past. Centuries before the present age of invention able and ingenious mechanicians, called, in Old German, *Antweremaister*,

FIG. 1.—MAGIC LANTERN INVENTED BY JOHANNES DE FONTANA ABOUT 1420.

and, in Latin, *cucignerii*, were employed by princes to devise engines of war. Many of these men have left notes and sketches, among which may be found the germs of inventions which did not attain full development and practical application until after they had been laboriously re-invented, perhaps centuries later.

For example, the magic lantern, the progenitor of modern optical projection apparatus, was described and

FIG. 2.—LAMP WITH GLASS CHIMNEY, 1500.

illustrated by Johannes de Fontana in 1420 (Fig. 1). It was devised for military purposes, the idea being to project at night horrible pictures which would throw the enemy's outposts into panic. The drawing clearly shows the wax candle, the demon painted on the glass slide, and its colossal projection on the wall. This device, if it was ever put to practical use, must have been very effective in an age of superstition. The in-

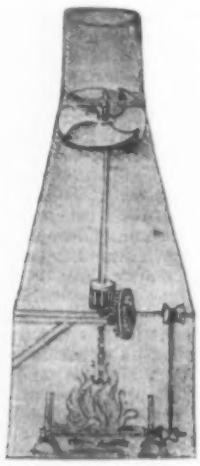


FIG. 3.—SPIT TURNED BY HOT AIR, 1500.

vention of the magic lantern is commonly attributed to the Jesuit monk Kircher, of Fulda, and the date ascribed to the invention is 1671, two hundred and fifty years after this drawing was made.

Fontana's lantern, furthermore, has a glass cylinder, identical in principle with the modern glass lamp chimney, which is generally supposed to have been invented by Quinquet in 1756. Leonardo da Vinci, the eminent artist and scientist, was evidently familiar with the glass chimney, for it appears in a design for a lamp drawn by him in 1500 (Fig. 2). This design also includes a hollow lens, filled with water, to increase the intensity of the light in one direction.

Leonardo da Vinci, who suggested the mechanical

FIG. 4.—LEONARDO DA VINCI'S PARACHUTE, 1514.

application of the elastic force of steam, also invented a spit turned by a screw propeller driven by the upward current of hot air caused by the fire (Fig. 3). Among the mechanical engineers of the end of the medieval period, Leonardo stands pre-eminent. No other has left us so many suggestions, written or drawn, as he. Yet, though his fame as an artist is universal, his scientific and technical work is little known, with the exception, perhaps, of his work in

FIG. 5.—DIVING DRESS, 1500.

aeronautics. Fig. 4 shows the parachute which Leonardo invented in 1514 and which was destined to be brought forward as a new invention by Le Normand in 1783. In connection with this drawing Leonardo writes, "Any person who possesses a stiff canvas tent of twelve ells height and breadth may let himself fall from any height, no matter how great, without fear of injury."

The old engineers also sought to enter the realm of fishes. Diving and swimming apparatus occupy much

FIG. 6.—THE DIVING BARREL OF ALEXANDER THE GREAT. FROM A MINIATURE MADE ABOUT 1320.

space in many of their illustrated manuscripts. Fig. 5 is taken from a comparatively modern work of this character, written by the knight Ludwig von Eybe zum Hartenstein at the beginning of the sixteenth century. The picture shows a leather diving dress with goggles and air tube, weighted shoes and a pole ladder, by which the descent and ascent were made. Many sunken objects may have been recovered, and many a good ship scuttled so secretly that the tale has not come down to us; for the old masters jealously guarded their knowledge and their art. Fame, social station and wealth depended on their ability to do things that no one else could do. To these inventors the problem of sustaining life under water must have appeared very alluring. The idea of the diving bell finds expression at a very early date. One of the oldest pictures of the diving bell occurs in a manuscript of the "Romance of Alexander," in the royal cabinet of engravings in Berlin. This picture, a painting in miniature, is very curious. Alexander the Great, wearing a crown, sits in a glass barrel (*"tonnel de wirre"*) which has been lowered into the sea by ropes, from a ship. The king has two lamps, presumably in order to study the denizens of the deep, one of which, many times larger than the ship or the barrel, is shown between them.

In a manuscript of the German poem "Salman and Moroff," written in 1190, and preserved in the royal library in Stuttgart, there was once a picture of a submarine boat, but the picture and some others have been cut out and stolen. The poem tells how Moroff built a small boat of leather which could not be injured by storms. Finding himself surrounded by twenty-four of the enemy's galleys he caused his boat to sink to the bottom of the sea where he remained *fourteen days*, breathing through an air tube. Though the idea common to the diving bell and the submarine boat is thus, as we see, seven hundred years old, the diving bell was first used in practice in 1538, when two Greeks exhibited it at the court of Charles V. of Spain and Austria. The first submarine or submergible boat was shown by Drebbel in London in 1624.

FIG. 7.—PADDLE-WHEEL BOAT, 1430.

The application of the paddle wheel to boats is another very old invention. The drawing of a paddle-wheel boat, shown in Fig. 7, dates from 1430. The accompanying text describes the boat as a war vessel employed by the Catalonians and carrying twenty-four men, though only two men are shown in the picture. In a sea fight such a vessel would appear to be more manageable than a galley with its many long oars.

The turbine or screw propeller was also invented long ago, not as a means of propulsion for boats, but as an improvement on the unwieldy mill wheel of the ordinary type. Its invention dates from the beginning of the 15th century and is ascribed, very strangely, to "a pope of Rome." The name of this wearer of the tiara is not definitely known. Fig. 8, a reproduction of a drawing made about 1575, shows, in the lower left-

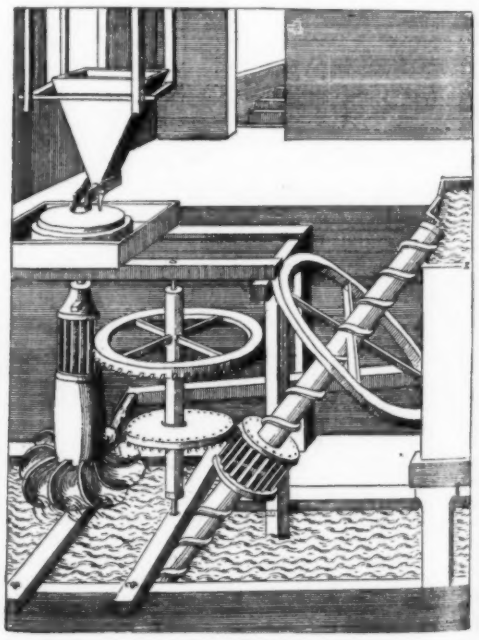


FIG. 8.—TURBINE, 1575.

hand corner, the peculiar form of turbine which Poncelet re-invented in 1826.

These old mechanicians devote a very large amount of space to pictures of cannon. In one of the oldest illustrated manuscripts on the art of war of which we have any knowledge, written about 1380, we find a revolving cannon, an invention which is usually supposed

to have been first made by Gatling in 1861. In 1405 we find the word "revolvere" applied to such a weapon by a German military engineer, so that not even the name is of American origin, although the American Colt, in 1851, was the first to manufacture revolvers on a commercial scale. The same desire to fire a number of shots, in rapid succession, from the same point, in order to overwhelm the enemy—for in those days each

FIG. 9.—REVOLVING CANNON, 1350.

loading occupied fully half an hour—suggested the rapid-fire and "organ" guns shown in Figs. 10 and 11, which are taken from a manuscript of the same date (1350).

Finally, not even the guillotine is the invention of the man whose name it bears. In Germany, during the Middle Ages, it was well known by the name of the "French trap," and Conradin, the last of the Hohenstaufens, lost his head by it as far back as 1268. Fig. 12, from a religious tract of 1510, is the earliest known picture of a guillotine. A better drawing, made in 1539 by the elder Lucas Cranach, is reproduced in Fig. 13. The picture represents the martyrdom of the twelve apostles and shows St. Matthew with his neck under the ax! The artists of those old days introduced contemporary costumes and accessories in their pictures of Biblical and historical scenes. After this period the guillotine fell into oblivion, where it remained until October 10, 1789, when the wholesale slaughter of the French revolution led the physician Ramon Guillotin to suggest the employment of a mechanical ax. Guillotin's machine, to which his name was first given in a satirical ballad, entered upon the performance of its grewsome task on April 25, 1792.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Die Gartenlaube.

NATURAL AND ARTIFICIAL PATINAS.*

THE brilliant surface of most metals and alloys is sooner or later covered with a coating of oxides or other chemical combinations which, in the case of copper and its alloys, is called patina. This has the effect of preserving the metal. This property was known to the ancients; it even appears that they were acquainted with the art of forming patina artificially. The formation and nature of patina depend on several factors; above all, on the composition of the alloy. Thus, bronzes containing 10 per cent of tin furnish a beautiful patina, a kind of enamel. The presence of 3 per cent of lead and small quantities of zinc is not an obstacle, while a large percentage of zinc causes the formation of a patina not agreeable to the eye, and of slight consistency. The composition of the alloy does

FIG. 10.—RAPID-FIRE GUN, 1350.

not generally correspond with that of the patina formed on its surface. Even when the copper predominates in an alloy, the patina always contains only a little copper, as the cupric combinations, the chlorides, oxychlorides, and oxycarbonates are lixiviated with water, especially water rich in carbonic acid.

The atmosphere and the elements which it contains play an important rôle in the formation of patina. A bronze statue, exposed to moist but pure air and to variations of temperature, is rapidly covered with a beautiful patina. On the contrary, the atmosphere of large cities, charged with hydrogen sulphide, sulphuric acid, soot, and other impurities, exerts an unfavorable action; statues are rapidly blackened. Soot and dust especially produce a caustic action. It is, therefore, important to keep them constantly in a polished state, in order that the impurities may not obtain a hold, and may be removed by the rain.

Severe climates, especially strong frosts, are unfavorable to the formation of a beautiful patina, because they occasion the scaling off gradually of the metal.

In the same way as the air, the nature of the ground in which antique objects are buried has an influence on the formation of the patina. Objects of bronze which have remained in a soil rich in sodium or other chlorides are covered with a patina composed of oxychlorides. Iron objects, which are rapidly deteriorated when exposed to moist air, are at times covered with a black coat of ferric protoxide, which insures their preservation, in the same manner as occurs with bronze patina. Such are the objects found in marshy countries or in pure sand. On the contrary, those buried in a soil rich in chlorides undergo rapid destruction, in consequence of the formation of soluble combinations of chlorine and iron.

Objects are often found so covered with rust as to have lost the lines of their form. Bronze coins are frequently covered with a very hard crust, composed of patina, sand, and clay, which it is impossible to remove by mechanical means. It is necessary to free them from their crust in order to bring to view the marks or inscriptions which they bear, or to protect them against ulterior destruction. In the same way it is necessary to free bronze objects from what is called "false patina." For this purpose, they are at times immersed in a solution of soda and water and covered with a layer of oil. But this treatment is inefficacious, either for cleaning the objects completely, or for securing their preservation.

Krefting has recommended an excellent process for treating iron objects that are much rusted. It consists in rolling around them zinc wire and immersing them in a weak solution of soda. But for assuring the contact of the metallic core with the zinc wire, it is necessary to scratch the object at several points. As the core is often quite weak and the entire object liable to

FIG. 12.—GUILLOTINE, 1510.

crumble, it is preferable in this case to place it in a small zinc basket and plunge it into a mixture formed of zinc powder and solution of soda. The zinc powder reduces the ferric oxides and salts into inferior oxides, and even to the metal itself. The zinc is dissolved in the solution of soda in excess.

Krause recommends the employment of aluminium powder, but it must be observed that aluminium dissolves too quickly in the solution of soda, and the greater part of this metal is then lost, without causing any reaction. The same process may be applied to the cleaning of objects of bronze. But for this, as for antique objects of iron, which still preserve a certain metallic core, the galvanic current will furnish the best results. The object is suspended to the negative pole as cathode, where the oxides are detached, in part mechanically under the action of the disengaged oxygen, and in part chemically, in consequence of their reduction into sub-oxides. Platinum, charcoal, or iron is employed as anode at the positive pole, according to the case. As electrolyte, potassium cyanide, a solution of soda, chlorhydric acid, or sal ammoniac may be employed. The latter is quite appropriate for the ordi-

FIG. 11.—"ORGAN GUN," 1350.

nary green patina. If, for instance, a coin is covered with a thick crust of patina mixed with sand and ashes, it may be suspended for some time as an anode, employing kitchen salt as the electrolyte. It is clear that for adapting them to the action of the galvanic current, the objects should be scraped so as to bring the metal to view. The employment of the galvanic current has numerous advantages over other methods. Its action is regular, the metal is not attacked at the cathode, and the intensity of the current may be regulated at will and arrested when desired. As projecting points are first attacked, the operation can be suspended as soon as the inscriptions or other reliefs become visible. The action of the current may also be restricted to a part of the object by covering other portions with a coating of lacquer or ceresine.

When the object is thus cleansed or reduced, its ulterior preservation is to be considered. For this purpose, it may be immersed in hot paraffine. Krause recommends heating it to 170 deg. C.; under the influence of heat the pores of the object open, and the paraffine penetrates better into the hot metal. Or, the object may be covered with a lacquer of celluloid. In both cases, the objects should be well washed in warm water as soon as they are taken from the galvanic bath and dried in the oven, first with alcohol, if there is occasion, then with ether to remove all traces of moisture, and afterward dipped in the celluloid lacquer and left to drain. The operation can be repeated several times. This lacquer, as also that known under the name of "metal preserver," is excellent for protecting the metal against the action of air and gases. It is also almost imperceptible. It is well to bathe the objects for a time after cleaning them in a solution of tannin, and then cover them with the lacquer. To avoid all misunderstanding, it may be said that the cleaning of antique objects, such as coins, should be undertaken only when they are covered with a thick crust, which may change the form, or with a hard patina, which prevents inscriptions and other signs in relief from being seen, and which cannot be removed mechanically.

FIG. 13.—ST. MATTHEW'S DEATH BY THE GUILLOTINE. FROM A DRAWING MADE IN 1539.

* From the German of Herr B. Setlig, in the Chemische Zeitung.

Recourse may also be had to it, for uncovering ornaments gilded on bronze, which disappear completely under the green patina, for deciphering inscriptions and finding the age of the object, or for removing false patina. In many cases it is useless to deprive the whole of an object of its antique character. A part may be cleaned by covering the remainder with a layer of ceresine.

A metallic object may also be covered with patina by the galvanic method; this is quite important for art founders of metals. The object is suspended as an anode, and the electrolyte selected according to the kind of patina desired. A solution of 4 per cent sal-ammoniac produces a beautiful patina; first red, then green on copper, brass, and bronze. To obtain a reddish brown shade, a weak solution of the oxide and carbonate of soda is employed. The oxygen formed at the anode first oxidizes the metal, and the carbonic acid set free carbonizes it. Meritens has employed the galvanic current for obtaining the deposit of a coat of ferric oxide on iron. Lismann has introduced a process for obtaining the patina of copper and its alloys. He employs as electrolytes solutions of carbonates and applies an electric current of one ampere per square meter of surface, and a tension of three volts. The chemical action is the same as that already explained, except that a greater tension seems to be necessary than that indicated, in consequence of the feeble conductivity of the water. If a solution of a cupric salt, or better sal-ammoniac, is employed as electrolyte, a tension of two volts is sufficient to obtain a patina in a very short time. The patina thus formed is scratch-brushed as ordinarily, and rubbed over with wax.

GOLD MOLECULES IN SOLUTION.*

By G. T. BEILBY.

IT has occurred to me that the practice of the cyanide process of gold extraction presents us with several new and interesting aspects of the problems of solution. As you are aware, the gold is first obtained from the ore in the form of a very dilute solution of cyanide of gold and potassium from which the metal has to be separated, either by passing it through boxes filled with zinc shavings, or by electrolysis in large cells.

The solution as it leaves the cyanide-vats may contain gold equal to 100 grains or more per ton, and as it leaves the precipitating-boxes it may contain as little as 1 or 2 grains and as much as 20 grains. In the treatment of slimes much larger volumes of solution have to be dealt with, and in this case solutions containing 18 grains per ton have been regularly passed through the precipitating-boxes, their gold content being reduced to 1½ grains per ton. In round numbers we may say that 1 gramme of gold is recovered from 1 cubic meter of solution, while 0.1 gramme is left in the solution. Even from the point of view of the physical chemist we are here in presence of solutions of a very remarkable order of dilution. A solution containing 1 gramme per cubic meter is in round numbers N/200,000, and the weaker solution containing 0.1 gramme is N/2,000,000. It is convenient to remember that the latter contains a little more than 1½ grains per ton. In experiments on the properties of dilute solutions the extreme point of dilution was reached by Kohlrausch, who employed solutions containing 1/100,000 of a gramme-molecule of solute per liter for his conductivity experiments. These solutions were therefore twice as strong as the gold solution with 1 gramme per cubic meter, and twenty times as strong as the more dilute solution. This fact must be my excuse for placing before you the results of a few simple calculations as to the molecular distribution in these solutions, which have certainly given me an entirely new view of what constitutes a really dilute solution from the molecular point of view.

In estimating the number of molecules in a given volume of solution the method adopted is to divide the space into minute cubical cells, each of which can exactly contain a sphere of the diameter of the molecule. In this way a form of piling for the molecules is assumed which, though not the closest possible, may quite probably represent the piling of water molecules. Taking the molecular diameter as 0.2×10^{-6} millimeters—a figure which is possibly too small for the water molecules and too large for the gold—it is found that a cubic millimeter of solution contains 125×10^{15} molecules, or 125 quadrillions. The head of an ordinary pin, if it were spherical, would have a volume of about 1 cubic millimeter.

If these water molecules could be arranged in a single row, each molecule just touching its two nearest neighbors, the length of the row would be 25,000,000 kilometers. A thread of these fairy beads, which contained the molecules of one very small drop of a volume of 6 cubic millimeters, would reach from the earth to the sun, a distance of about 150,000,000 kilometers.

In a solution containing 1½ grains of gold per ton, or 1 decigramme per cubic meter, the ratio of gold molecules to water molecules is as 1 : 193,000,000. Each cubic millimeter of the solution, therefore, contains 6,500,000,000 gold molecules. If these are uniformly distributed throughout the solution each will be about 400 micro-millimeters, or 1/60,000 of an inch, from its nearest neighbors. This is not really very wide spacing, for the point of the finest sewing-needle would cover about 1,500 gold molecules.

If a cubic meter of solution could be spread out in a sheet one molecule in thickness it would cover an area of 1,680 square miles, and nowhere in this area would it be possible to put down the point of the needle without touching some hundreds of gold molecules simultaneously.

According to Prof. Liversidge, sea-water contains on the average about 1 grain of gold per ton. If this is the case, then the above figures for the dilute cyanide solution apply with only a slight modification to sea-water. No drop, however small it may be, can be removed from the ocean which will not contain many millions of gold molecules, and no point of its surface can be touched which is not thickly strewn with these. From this molecular point of view we must realize that our ships literally float on a gilded ocean!

From time to time adventurers arise who attempt to launch upon this gilded ocean unseaworthy ships freighted with the savings of the trusting investor. In order that nothing which has been said here may tempt anyone to contribute to the freighting of these ships, let me hasten to point out that the weakest of the cyanide solutions here referred to is richer in gold than sea-water is reported to be. The practical conclusion from this comparison is sufficiently obvious. If the cyaniding expert, whose business it is to extract gold from dilute solutions, finds that it does not pay to carry this extraction beyond a concentration of 2 or 3 grains per ton, even when the solution is already in his hand, and when, therefore, the costs of treatment are at their minimum, how can it possibly pay to begin the work of extraction on sea-water, a solution of one-half the richness, which would have to be impounded and treated by methods which could not fail to be more costly in labor and materials than the simple process of zinc-box precipitation? It is generally unsafe to prophesy, but in this case I am rash enough to risk the prediction that if ever the gold mines of the Transvaal are shut up it will not be owing to the competition of the gold resources of the ocean.

In these calculations with reference to the dilute cyanide solutions it is assumed that the gold molecules are uniformly distributed, that they are practically equidistant from each other. There appears to me to be considerable doubt whether we have any right to make this assumption. Leaving out of account for the moment the action of the water molecules, it would appear that as long as the gold molecules are so numerous that a uniform distribution would bring them within the range of each other's attraction, we can imagine that all submerged molecules would be in equilibrium so far as the attractions of their own kind are concerned, being subjected to a uniform pull in all directions. This condition would certainly make for uniform distribution. But when the distance between them exceeds the range of the molecular forces, it is evident that an entirely new condition is introduced, and it seems not improbable that the widely distributed molecules would tend to drift into clouds in which they are brought back within the range of these forces. The range of the cohesive forces in water and aqueous liquids is usually taken from 50 to 100 micro-millimeters, and I am disposed to think that ten times this amount would not be an excessive estimate of the range in the case of gold. If the range for gold be taken as 500 micro-millimeters, then the gold molecules of the dilute gold solution, which are spaced at 400 micro-millimeters apart, are just within the range of each other's attraction, and their distribution is, therefore, likely to be uniform. But by a further dilution to half concentration, the equilibrium would be liable to be disturbed, and denser clouds of gold molecules would be formed, with less dense intervals between them.

In preparing the zinc boxes through which the gold solution is passed, very great care has to be exercised to insure that the contact surface of the zinc is used to the best advantage. With this object the packing of the zinc shavings is so managed that the solution is spread over the zinc surface in as thin sheets as possible. The object, of course, is to bring as many of the gold molecules as possible into actual contact with the zinc. The gold molecules found in the solution leaving the boxes are those which have not been in contact with the zinc. Yet we have seen that these molecules are still so numerous that they are within 1/60,000 of an inch of each other. If these molecules are in a state analogous to the gaseous state, with diffusive energy of the same order as that of the gas molecule, it is difficult to imagine how they can escape without coming in contact with the zinc surface during their tortuous passage through the boxes and being deposited there. Yet they do escape, even when the velocity of the solution in passing over the zinc surfaces is so slow as 10 centimeters per minute or 1.6 millimeters per second.

We may regard the condition of these isolated gold molecules, or the more complex auricyanide of potassium molecules, as typical of that of the solute molecules in a dilute solution of any non-volatile solid. They are *solid* molecules sparsely distributed among a multitude of intensely active solvent molecules, the temperature of the solution being many hundred degrees below that at which they could of themselves assume the greater freedom of the liquid or gaseous state. These solute molecules have to a great extent been set free from the constraining effect of their cohesive forces, *but it is important to remember that this freedom has not been attained by the increase of their own kinetic energy as in liquefaction by heat.* Their freedom and the extra kinetic energy they have acquired have in some way been imparted to them by the more active solvent molecules; for, if the solvent could be suddenly removed, leaving the solute molecules still similarly distributed in a vacuous space, they would eventually condense into a solid aggregate. This must be the case, for the non-volatile solute has no measurable vapor pressure at the temperature of the solution. The kinetic energy of the solute molecules is of itself quite insufficient to endow them with the properties of the gaseous or even of the liquid molecule, even when their cohesive forces have been weakened or overcome by separation.

If the energy employed in this separation is not intrinsic to the solute molecule then it must in some way have been imparted by the solvent molecules. It therefore becomes important to compare the energy endowment of one set of molecules with that of the other.

Compared with other solids, ice at its freezing point has very little hardness or tenacity; the cohesion of its molecules has been much relaxed by the great absorption of heat energy between the absolute zero and the freezing point. If an average specific heat of 0.5 over the whole range be assumed, the heat absorption of one gramme amounts to 136.5 calories. In the transition to the liquid state at 0 deg. a further absorption of 79 calories takes place, so that a gramme of liquid water at the freezing point contains the heat energy of 215.5 calories. The fact that water has the high vapor pressure of 4.6 millimeters of mercury at the freezing point is probably a result of this enormous store of energy. As a liquid, therefore, it is natural to expect that its molecules will exhibit effects proportionate to this great store of energy. This expectation appears to be realized when we consider not only its properties as the universal solvent, but its osmotic and diffusive energy in solutions in which it is the solvent.

To complete the comparison it is only necessary to calculate the heat energy of gold at 0 deg. Taking its specific heat as 0.032, a gramme of gold at 0 deg. contains 8.7 calories. A gramme-molecule, therefore, contains in round numbers 1,700 calories as compared with 3,880 calories in a gramme-molecule of water.

Taking into consideration not only this greater store of energy, but also the much smaller cohesive force of water as compared with the majority of solid solutes, there can be no doubt that the active rôle in aqueous solutions of this type must be assigned to the solvent, not to the solute molecules.

This leads to the important conclusion that the energy of solution, of diffusion, and of osmosis is due, not to the imaginary gaseous energy of the solute, but to the actual liquid energy of the solvent molecules. When this conclusion is reached a new physical explanation of these phenomena is in our hands, and we are relieved from the strain to the imagination involved in the application of the gas theory to solutions of non-volatile solids.

This transference of the active rôle to the solvent molecules does not in any way affect the well-established conclusions based on the laws of thermodynamics as to the energy relations in these phenomena, for it has always been recognized that these conclusions have reference to the average conditions prevailing in large collections of relatively minute units. Wherever the gas analogy has appeared to hold it has not necessarily involved more than this, that the observed effects are in proportion to the number of these minute units in a given volume.

In applying the gas theory to the physical explanation of osmotic pressure it has been the custom to regard this pressure as directly due to the bombardment of the semi-permeable membrane by the solute molecules. But this conception completely ignores the fact that the pressure developed is a hydrostatic, not a gaseous pressure, and that the hydrostatic pressure results directly from *the penetration of the solvent molecules from the other side of the partition.*

It appears to me more natural to abandon the gas analogy altogether, to regard the molecules as in the solid and liquid condition proper to their temperature, and to apportion to them their respective parts in the active changes according to their obvious endowment of energy.

Applying this view to the case of a solution and a solvent separated by a semi-permeable membrane, it is seen that the pressure rises on the solution side, because the pure solvent molecules on the other side have some advantage for the display of their energy over the similar molecules in the solution. *This effect in its most general form may be attributed to the dilution of the solvent by the solute molecules.* In cases where the osmotic pressure appears to obey Boyle's law the effect is exactly measured by the number of solute molecules per unit volume. But the facts of this position are in no way changed if the effect is taken to be due to the activity of an equal number of solvent molecules, for we then see that each solute molecule by canceling the activity of one solvent molecule on the solution side permits a solvent molecule from the other side to enter the solution.

What the exact mechanism of this cancelation is there is at present no evidence to show, and the caution originally given by Lord Kelvin with reference to the undue forcing of the gas analogy must also be applied to the suggestion now put forward.

* Abstracted from an address delivered before the British Association for the Advancement of Science.

RECENT FOREIGN METHODS FOR THE PRODUCTION OF CELLULOID AND SIMILAR SUBSTANCES.*

NEW CELLULOID.—M. Ortmann has ascertained that turpentine produced by the *Pinus larix*, generally denominated Venice turpentine, in combination with acetone (dimethyl ketone) yields the best results; but other turpentines, such as the American from the *Pinus australis*, the Canada turpentine from the *Pinus balsamea*, the French turpentine from the *Pinus maritima*, and ketones, such as the ketone of methyl-ethyl, the ketone of dinapnthyl, the ketone of methyl-oxynaph-

* Compiled and translated from French, German and Italian periodicals.

thyl, and the ketone of dioxynaphthyl, may be employed.

To put this process in practice, a kilogramme of pyroxyline is prepared in the usual manner, and mixed with 0.065 liter of turpentine, or ¼ liter of ketone and ¼ liter of ether; ½ or ¾ of a liter of methyl alcohol is added, and a colorant, such as desired. Instead of turpentine, resins derived from it may be employed. If the employment of camphor is desired to a certain extent, it may be added to the mixture. The whole is shaken and left at rest for about twelve hours. It is then passed between hot rollers, and finally pressed, cut, and dried, like ordinary celluloid.

The product thus obtained is without odor, when camphor is not employed; and in appearance and properties it cannot be distinguished from ordinary celluloid, while the expense of production is considerably reduced.

Formol-Albumen for Preparation of Celluloid.—Formol has the property of forming combinations with most albuminoid substances. These are not identical with reference to plasticity, and the use which may be derived from them for the manufacture of plastic substances. This difference explains why albumen should not be confounded with gelatine or casein. Keeping this in view, the Société Anonyme l'Oyonnaxienne has originated the following process:

A. The albumen may be that of the egg or that of the blood, which are readily found in trade. The formolizing may be effected in the moist state or in the dry state. The dry or moist albumen is brought into contact with the solution of commercial formol diluted to 5 or 10 per cent for an hour. Care must be taken to pulverize the albumen, if it is dry. The formol penetrates rapidly into the albuminoid matter, and is filtered or decanted and washed with water until all the formol in excess has completely disappeared; this it is easy to ascertain by means of aniline water, which produces a turbid white as long as a trace of formic aldehyde remains.

The formol-albumen is afterward dried at low temperature by submitting it to the action of a current of dry air at a temperature not exceeding 40 deg. C. Thus obtained, the product appears as a transparent corneous substance. On pulverizing, it becomes opaque and loses its transparency. It is completely insoluble in water, but swells in this liquid.

B. The formol-albumen is reduced to a perfectly homogeneous powder, and mixed intimately with the plastic matter before rolling. This cannot be considered as a sufficient means for usefully effecting the mixture. It is necessary to introduce the formol-albumen, in the course of the moistening, either by making an emulsion with camphor-alcohol, or by mixing it thoroughly with nitro-cellulose, or by making simultaneously a thorough mixture of the three substances. When the mixture is accomplished, the paste is rolled according to the usual operation. The quantity of formol-albumen to add is variable, being diminished according to the quantity of camphor.

Instead of adding the desiccated formol-albumen, it may previously be swollen in water in order to render it more malleable.

Instead of simple water, alkalinized or acidified water may be taken for this purpose, or yet alcoholized water. The albumen, then, should be pressed between papers or cloths, in order to remove the excess of moisture.

Plastic Substances of Nitro-Cellulose Base.—To manufacture plastic substances the Compagnie Française du Celluloid commences by submitting casein to a special operation. It is soaked with a solution of acetate of urea in alcohol; for 100 parts of casein 5 parts of acetate of urea and 50 parts of alcohol are employed. The mass swells, and in forty-eight hours the casein is thoroughly penetrated. It is then ready to be incorporated with the camphored nitro-cellulose. The nitro-cellulose, having received the addition of camphor, is soaked in the alcohol, and the mass is well mixed. The casein prepared as described is introduced into the mass. The whole is mixed and left at rest for two days.

The plastic pulp thus obtained is rolled, cut, and dried like ordinary cellulose, and by the same processes and apparatus. The pulp may also be converted into tubes and other forms, like ordinary celluloid.

It is advantageous to subject the improved plastic pulp to a treatment with formaldehyde for the purpose of rendering insoluble the casein incorporated in the celluloid. The plastic product of nitro-cellulose base, thus obtained, presents in employment the same general properties as ordinary celluloid. It may be applied to the various manufacturing processes in use for the preparation of articles of all kinds, and its cost price diminishes more or less, according to the proportion of casein associated with the ordinary celluloid. In this plastic product various colorants may be incorporated, and the appearance of shell, pearl, wood, marble, or ivory may also be imparted.

Improved Celluloid.—This product, introduced by Tissier & Magnier, is obtained by mingling with celluloid under suitable conditions gelatine or strong glue of gelatine base. It is clear that the replacement of part of the celluloid by the gelatine, of which the cost is much less, lowers materially the cost of the final product. The result is obtained without detriment to the qualities of the objects. These are said to be of superior properties, having more firmness than those of celluloid. And the new material is worked more readily than the celluloid employed alone.

The new product may be prepared in open air or in a closed vessel under pressure. When operated in the air, the gelatine is first immersed cold (in any form, and in a state more or less pure) in alcohol marking about 60 deg. C., with the addition of a certain quantity (for example 5 to 10 per cent) of crystallizable acetic acid. In a few hours the material has swollen considerably, and it is then introduced in alcohol of about 90 deg., and at the same time the celluloid pulp (camphor and gun cotton), taking care to add a little acetone. The proportion of celluloid in the mixture may be 50 to 75 per cent of the weight of the gelatine, more or less, according to the result desired. After heating the mixture slightly, it is worked, cold, by the rollers ordinarily employed for celluloid and other similar pastes, or by any other suitable methods.

The preparation in a closed vessel does not differ from that which has been described, except for the introduction of the mixture of gelatine, celluloid, alcohol, and acetone, at the moment when the heating is to be accomplished in an autoclave heated with steam, capable of supporting a pressure of 1 or 2 kilogrammes, and furnished with a mechanical agitator. This method of proceeding abridges the operation considerably; the paste comes from the autoclave well mingled, and is then submitted to the action of rollers. There is but little work in distilling the alcohol and acetic acid in the autoclave. These may be recovered, and on account of their evaporation the mass presents the desired consistency when it reaches the rollers. Whichever of the two methods of preparation may be employed, the substance may be rolled as in the ordinary process, if a boiler with agitator is made use of; the mass may be produced in any form.

Preparation of Uninflammable Celluloid.—The operation of this process by M. Woodward is the following: In a receiver of glass or porcelain, liquefied fish-glue and gum arabic are introduced and allowed to swell for twenty-four hours in a very dry position, allowing the air to circulate freely. The receiver is not covered. Afterward it is heated on a water bath, and the contents stirred (for example by means of a porcelain spatula), until the gum is completely liquefied. The heating of the mass should not exceed 25 deg. C. Then the gelatine is added in such a way that there should be no solid pieces. The receiver is removed from the water bath and colza oil added, while agitating anew. When the mixture is complete, it is left to repose for twenty-four hours.

Before cooling, the mixture is passed through a sieve in order to retain the pieces which may not have been dissolved. After swelling, and the dissolution and purification by means of the sieve, it is allowed to rest, still in the same position, with access of air. The pellicle formed while cooling may be removed. The treatment of celluloid necessitates employing a solution completely colorless and clear. The celluloid to be treated while it is still in the pasty state should be in a receiver of glass, porcelain, or similar material.

The mass containing the fish-glue is poured in drop by drop, while stirring carefully, taking care to pour it in the middle of the celluloid and to increase the surface of contact.

When the mixture is complete, the celluloid is ready to be employed and does not produce flame when exposed.

The solution of fish-glue may be prepared by allowing 200 grammes of it to swell for forty-eight hours in a liter of cold distilled water. It is then passed through the sieve, and the pieces which may remain are broken up, in order to mingle them thoroughly with the water. Ten grammes of kitchen salt are then added, and the whole mass passed through the sieve.

This product may be utilized for the preparation of photographic films or for those used for cinematographs, or for replacing hard caoutchouc for the insulation of electric conductors and for the preparation of plastic objects.

Substitute for Camphor in the Preparation of Celluloid and Applicable to Other Purposes.—In this process, introduced by Magnier & Brangier, commercial oil of turpentine, after being rectified by distillation over caustic soda, is submitted to the action of gaseous chlorhydric acid, in order to produce the solid monochlorhydrate of turpentine. After having by means of the press extracted the liquid mono-chlorhydrate, and after several washings with cold water, the solid matter is desiccated and introduced into an autoclave apparatus capable of resisting a pressure of six atmospheres. Fifty per cent of caustic soda calculated on the weight of the mono-chlorhydrate, and mingled with an equal quantity of alcohol, is added in the form of a thick solution. The apparatus is closed and heated for several hours at the temperature of 140 to 150 deg. C. The material is washed several times for freeing it from the mingled sodium chloride and sodium hydrate, and the camphor resulting from this operation is treated in the following manner:

In an autoclave constructed for the purpose, camphene and water strongly mixed with sulphuric acid are introduced and heated so as to attain 3 kilogrammes of pressure. Then an electric current is applied, capable of producing the decomposition of water. The mass is constantly stirred, either mechanically or more simply by allowing a little of the steam to escape by a tap. In an hour, at least, the material is drawn from the apparatus, washed and dried, sublimed according to need, and is then suitable for replacing camphor in its industrial employments, for the camphene is converted entirely or in greater part into camphor, either right-hand camphor, or a product optically inactive, according to the origin of the oil of turpentine made use of.

In the electrolytic oxidation of the camphene, instead of using acidulated water, whatever is capable of furnishing, under the influence of the electric current, the oxygen necessary for the reaction, such as oxygenized water, barium bioxide, and the permanganates, may be employed.

Plastic and Elastic Composition.—Formaldehyde has the property, as known, of removing from gelatine its solubility and its fusibility, but it has also another property, prejudicial in certain applications, of rendering the composition hard and friable. In order to remedy this prejudicial action M. Deborda adds to the gelatine treated by means of formaldehyde, oil of turpentine, or a mixture of oil of turpentine and German turpentine or Venice turpentine. The addition removes from the composition its friability and hardness, imparting to it great softness and elasticity. The effect is accomplished by a slight proportion, 5 to 10 per cent.

Production of Substances Resembling Celluloid.—Most of the substitutes for camphor in the preparation of celluloid are attended with inconveniences limiting their employment and sometimes causing their rejection. Thus, in one case the celluloid does not allow of the preparation of transparent bodies; in another, it occasions too much softness in the products manufactured; and in still another, it does not allow of pressing, folding, or other operations, because the mass is too brittle; in still others, combinations are produced which in time are affected unfavorably by the coloring substances employed.

M. Callenberg has found that the halogenous derivatives of etherized oils, principally oil of turpentine, and especially the solid chloride of turpentine, which is of a snowy and brilliant white, and of agreeable odor, are suitable for yielding, either alone or mixed with camphor or one of its substitutes, and combined by ordinary means with nitrated cellulose, or other ethers of cellulose, treated with acetic ether, a celluloidic product, which, it is said, is not inferior to ordinary celluloid and has the advantage of reduced cost.

Elastic Substitute for Celluloid.—Acetic cellulose, like nitro-cellulose, can be converted into an elastic corneous compound. The substances particularly suitable for the operation are organic substances containing one or more hydroxy, aldehydic, amide, or ketonic groups, as well as the acid amides. Probably a bond is formed when these combinations act on the acetate of cellulose, but the bond cannot well be defined, considering the complex nature of the molecule of cellulose. According to the mode of preparation, the substances obtained form a hard mass, more or less flexible. In a soft state, copies of engraved designs can be reproduced in their finest details. When hardened, they can be cut and polished. In certain respects they resemble celluloid, without its inflammability, and they can be employed in the same manner. They can be produced by the following methods, the Lederer process:

1. Melt together one part of acetate of cellulose and one and a half parts of phenol at about the temperature of 40 or 50 deg. C. When a clear solution is obtained, place the mass of reaction on plates of glass or metal slightly heated and allow it to cool gradually. After a rest of several days, the mass, which at the outset is similar to caoutchouc, is hard and forms flexible plates, which can be worked like celluloid.

2. Compress an intimate mixture of equal parts of acetic cellulose and hydrate of chloral or of aniline, at a temperature of 50 or 60 deg. C. and proceed as in the previous case.

In the same way a ketone may be employed, as acetophenone, or an acid amide, as acetamide.

A NEW DEPARTURE IN THE CHEMISTRY OF ALBUMINOIDS.

THE investigations of many chemists have been directed of late toward the artificial production of albuminoids, and Prof. Fischer, of Berlin, has been among the pioneers in this field of chemical activity. At a recent meeting of the German Chemical Society he made public the present state of his investigations in the chemistry of those bodies which are known to constitute the structural principle of all organized beings.

It may be said that results previously obtained by others were of a fragmentary description, hardly constituting an advance in this important problem. This non-success was mainly due to the complexity of the albumen-molecule, which is the most complicated body dealt with by chemists. The molecular structure of albumen is however known to be susceptible of splitting, when albumen components of less complicated composition than the aggregate molecule are obtained which accordingly are more readily susceptible of investigation. The albumen molecule is split up by means of acids, alkalis or ferments, when substances bearing a more or less close relationship to genuine albuminoids are obtained. These molecular components may be divided into those of the higher and lower order, the former being the bodies known by the name of peptones and albumoses, which are of a complex composition extremely similar to albuminoids proper. Of the components of the lower order the amino-acids have assumed especial importance, and being of less involved composition, it has been possible to investigate their constitution. In fact, it is with these amino-acids that Fischer's work started, the methods of obtaining them being considerably improved, while a reliable and suitable method of their synthesis was developed. On this basis he was enabled to investigate more closely the albuminoids, examining the most varied representatives of this class of bodies as to the amino-acids contained therein. A number of hitherto unknown albuminoids were thus found, and interesting facts as to the behavior of albuminoids in general were brought out. Fischer was also successful

in producing by synthesis some other products of albumen.

As the amino-acids are considerably simpler in composition than the albuminoids constituted by their combination, Fischer tried to obtain by the artificial combination of these substances a composite body that would be a *preliminary step in the production of genuine albumen*, being comparable to albuminoids of relatively simple composition, e. g., peptones. A process for coupling several such amino-acids together was accordingly developed, obtaining bodies of increasing complexity by the coupling together of more and more such components. Many artificial compounds of this kind were prepared by the lecturer.

These bodies obtained by a synthetical method are closely related to true albumen, and in spite of some differences still existing between genuine peptones and the artificial "poly-peptides" these two classes of bodies show a behavior in the main identical. The most interesting fact is that both are split up by the pancreas ferment, which reaction is known to constitute the process of digestion. It may be said that the artificial production of true albumen, to which the continuation of these investigations will most probably lead, would mean an invaluable boon to humanity.

APPARATUS FOR INTRA-THORACIC OPERATIONS.

Our lungs are inclosed in the thoracic cavity, which is tight. During our inspiration, the thorax expands, the lungs distend, and, as a consequence of their dilatation, a minimum pressure forms in the interior. If the mouth and nose are free, the air enters the lungs as a consequence of the difference in pressure between the external and internal air. If an aperture be formed in the thoracic cavity, the external air will enter the pleural cavity, such difference in pressure will no longer exist, and the lung will remain inactive and collapse. This is what is called a pneumo thorax. If this is on one side only, it will be possible for a person to continue to breathe with the other lung. Although in order to remove tumors from the mediastinum it might be desired by the physician in some cases to incise the pleura of both sides, it has been impossible to perform such an operation up to the present, since a double pneumo thorax would occur and the patient would immediately suffocate.

An endeavor has for a long time been made to prevent the pneumo thorax. Doctors Tuffier and Hallion have tried to solve this question, and with some success, by inducing artificial respiration in animals by insufflation according to the Claude Bernard method, while at the same time Drs. Quena and Longuet have sought the solution of the problem in the maintaining of a difference of pressure between the intra-alveolar and surrounding air. Two methods suggested themselves to their mind: (1) that of diminishing the extra-thoracic pressure, the intra-pulmonary pressure remaining the same, and the physician having to operate in a vacuum; and (2) that of increasing the intra-bronchial pressure in order that the latter may, during the operation, constantly apply the serous membrane of the lung to the aperture formed in the thoracic cavity.

Dr. Sauerbruch, of Germany, has recently maintained such difference in pressure by placing the patient's body in a chamber of rarefied air, and leaving his head outside of it under the normal atmospheric pressure. It is necessary for the operators to remain in this chamber and undergo the diminution in the pressure of the air. As the chloroformer remains outside, the operator can communicate with him only by telephone, and this is very inconvenient. Moreover, the chamber is very large, not easily transportable, weighs about 1,000 pounds, and costs $1,000.

Sauerbruch conceived the idea of reversing the pressure, that is to say, of leaving the body of the patient under the normal atmospheric pressure and of placing his head alone with the anæsthetizer in a case of compressed air. But while he himself had no great confidence in this process, Dr. Brauer, of Marburg, to whom this same idea occurred simultaneously, followed it up and devised a very ingenious apparatus which imprisons the head alone of the patient in a glass case, while the operator and chloroformer remain on the outside, are in no wise inconvenienced, and are capable of communicating with each other as in ordinary operations.

Dr. Brauer's apparatus consists of two parts: (1) A Roth-Draeger chloroforming apparatus; and (2) of a Brauer compressed air respiration apparatus.

The chloroforming apparatus permits of administering the chloroform drop by drop, slowly and progressively, and mixed with much air and oxygen in order to prevent accidents. Its principle consists in employing the live force of the oxygen (which escapes from a flask in which it is compressed to 150 kilogrammes per square centimeter) for aspiring through a drop-counter the chloroform contained in an independent flask, and for introducing it into a gold beater's skin bag, forming a sort of reservoir, whence the patient inhales the gas. A regulating screw placed upon the drop-counter measures the discharge of the chloroform per minute. The anæsthetization is begun by administering to the patient from 30 to 45 drops of chloroform per minute. The anæsthetization is generally effected in 8 or 10 minutes, and it is then very easy to reduce to a minimum the number of drops required to maintain the anæsthetization without any danger. The patient sleeps regularly and gives not the least bit of anxiety.

It is well to remember that the idea of proportioned mixtures upon which the apparatus is based is due to Paul Bert. This scientist demonstrated that it was possible with 10 grammes of chloroform contained in 30 liters of air to kill an animal in a few minutes, while it is possible to give 40 grammes without any danger if the vapor disengaged therefrom is absorbed after being mixed with 400 liters of air. A bulky apparatus, a sort of gasometer, in which this proportioned mixture of chloroform and air was experimented with at the Hospital Saint Louis, was afterward improved by Raphael Dubois, but finally abandoned. It was but three years afterward that an apparatus based upon this principle was devised by Dr. Wohlgemuth, of Berlin, although it gave no practical results until it was improved by Dr. Roth, of Lubeck.

THE BRAUER-DRAEGER APPARATUS FOR INTRA-THORACIC OPERATIONS.

The Roth apparatus was soon succeeded in England by that of Vernon Harcourt, through which the patient breathes in air through a vessel of chloroform. With this it is possible, according to the greater or less quantity of air that is allowed to pass, to give a mixture more or less saturated with chloroform. Similar apparatus have been constructed at Paris by Drs. Reynier, Ricard, and Tuffier. It is only now that surgeons are beginning to discard the use of the dangerous anti-physiological compress.

Serious accidents have too often been attributed to the impurity of the chloroform used or to the idiosyncrasy of the patient, although really due to the defective manner in which the anæsthetic was administered, for if chloroform be poured upon a compress without counting the drops, empirically or somewhat at hazard, and if the compress be applied too closely to the mouth and nose of the patient, the chloroform may be at a dangerous tension under the compress and saturate the blood, so that the nervous cells may be affected, and alarming symptoms or even death may occur. It is for such a reason that Paul Bert advised the administration to the patient of chloroform vapor diluted with air, as is done in the Roth-Draeger apparatus.

As for the Brauer apparatus properly so called, that consists of a glass case of a cubical form and of a capacity of 30 liters. An aperture permits of the introduction of the patient's head already chloroformed. To effect this the head is covered with a sort of hood of India rubber with a cape, embracing the nape and neck and leaving free the eyes, the nose, and the mouth. The part that embraces the neck is fixed by a ribbon upon the ring of the aperture of the case, so that the neck is in no wise compressed. In order to obtain the necessary pressure of air, recourse is had to a rotary pump, which forces the air, not directly into the glass case, but into a large blower which forms a reservoir and through which the pressure is perfectly regulated and kept absolutely constant, 800 liters of air per minute thus circulating through the case for guaranteeing a sufficient ventilation. The expired as well as the surplus air passes off through a large valve. Two apertures in the sides of the case permit the operator to introduce his arms into the interior.

In the course of this maneuver no communication can take place with the external air, owing to the fact that the hands of the operator are inserted in long rubber gloves fixed to rings in the apertures. There is also a third aperture closed by a long glove which permits of the intervention of an assistant in case of necessity. The advantage of the apparatus consists especially in the fact that the respiration of the patient is kept calm and constant during the entire period of the operation, and under perfect conditions from the view point of hæmatosis. The manometer remains invariably at a pressure of 10 centimeters of water. In the regulation of the pressure, the chief role is played by a Draeger valve, which consists of a plate of metal resting upon a water level, and the resistance of which is regulatable by means of a traveler moving upon an axis passing through its center and permitting of opposing a force that may be varied at will to the elastic force of the air expired.

In order that the Brauer apparatus might be associated with the Roth chloroforming apparatus it became necessary to place the gold beater's skin reservoir, from which the patient aspires the mixture of chloroform and oxygen, under a bell glass communicating with the compressed air case, in order that the pressure might remain equal in the two vessels.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE RISE OF ANTHROPOLOGY.

FROM the earliest times, thinking men classed mankind in two or more divisions, of which the lower was regarded as ranking with brutes; and this view survives to-day among most primitive peoples. So the ancients divided the human genus into two species, *Homo sapiens* and *Homo brutus*, and held the former to possess and the latter to lack mind and soul. As exploration proceeded and knowledge of remoter peoples progressed during recent centuries, scientific observers were more impressed by the resemblances among than by the differences between the human types, and were unable to discover or define the brutal species recognized by the ancients. Yet the question of affinity or relationship between man and lower organisms —and no greater question has arisen in all human history—refused to down, and reappeared in inquiries concerning the origin of man. In England Huxley and Darwin, and in Germany Haeckel, showed that the structure of the lowest humans more nearly resembles that of the highest quadrumanes (the "four-handed" ape-like animals) than that of the highest humans, and from all known facts of both structure and development drew the inference that just as lower humans grow into higher types, so, in earlier times, some of the higher quadrumanes grew into lower humans; and much was said of the prospective finding of a "missing link" combining more nearly than any known organisms the characters of human and quadrumane beings—a prophecy verified a quarter century later by the discovery of *Pithecanthropus erectus* (erect monkey-man) in Java. The effect of the discussions and discoveries was to keep alive the idea of the close connection between man and the lower animals. Even before the discovery in Java, renowned anthropologists in Europe, and especially in Germany, noted a correspondence between the white, yellow, brown, and black races of the old world and four leading types of quadrumanes, and suggested that the four human stocks were fundamentally distinct and had descended (or ascended) from the sub-human species. From this suggestion sprang the doctrine of polygenesis, which was opposed by those who preferred the theory of monogenesis, i. e., the descent of all mankind from a single pair—the theory fostered by tradition and the doctrine of evolution, and originally held by all peoples. One effect of the ensuing discussion was to fix more clearly in all minds the classification of the peoples of the old world in four ethnic divisions or races; another was to keep in mind the idea of our ancestors that at least some men and the lower animals are closely akin. At every stage the views of the experts found their way into general thought, too often with some distortion; and partly for this reason all the world desires to see the lowest and remotest types of mankind, preferably in connection with those higher quadrumanes whose man-like features and movements form a source of endless interest to old and young alike.

To Preserve Cast-Iron Objects from Rust.—This process is recommended especially for cementing furniture. Brush the metal smartly with a steel-wire brush; then coat twice with red lead or with graphite paint. When this is dry and hard, apply a coating composed of equal parts of lampblack, oil of turpentine, and varnish. Finish with a layer of lampblack mixed with carriage varnish.—La Nature.

A VISIT TO THE FIRST SHOW OF THE AERO CLUB OF AMERICA.*

By CARL E. MYERS.

As an active member of the lately founded Aero Club of America, I found myself and exhibit aboard the New York Central train *en route* from my balloon farm at Frankfort, N. Y., to attend the first exhibit of the club in the 69th Regiment Armory, New York, held in conjunction with the Automobile exhibit of the Automobile Club of America.

My exhibit, culled from a barn full of aeronautical relics, was historically famous. It included the first device in America which had successfully propelled and guided a hydrogen gas balloon by man power; the first electrically-impelled and electrically-guided airship; and the photographic exhibit of nineteen successfully working airships, and over one hundred hydrogen balloons built or "raised" at my balloon farm for the United States Agricultural or War Department, and operated by me or under my instruction. One would scarcely believe how much this entire exhibit could be condensed for the purpose of transportation. Hardly noticeable on the rack above my car seat was the entire framework, motor, screw propeller, and guiding planes of a complete airship which had made 120 mid-air flights in all directions, and which ran 700 miles as measured by an anemometer which it carried. The gas spindle of this electric aerial torpedo was empty, and now rolled up like a silk cocoon within my suit case.

In the baggage car of the train was a wickerwork balloon car, the size of a common trunk. Its weight was 40 pounds. Inside this wicker car, lying collapsed upon its bottom, was another balloon car weighing 11 pounds, and composed of a hammock netting cord bag, within which was a floor of thin, cross-laid veneering, while a metal basket rim permitted attachment to any balloon for carrying two persons. Within this collapsed netting car was still another, flat, and weighing eight ounces. When extended it had a capacity for eight passengers—homing Antwerp carrier pigeons, which it had carried, and which were the first in America to be flown from a balloon.

The larger netting car had made over 300 flights. It was equipped with a hand crankshaft carrying a large revolving screw sail for propulsion, and a yard-square, universally-jointed rudder, useful for propelling and steering. This whole affair, known as the "Flying Dutchman," was invented and patented by Mrs. C. E. Myers. With it, during a single one of her hundreds of balloon flights, she attained the record for greatest height and speed in America—25,000 feet elevation and 90 miles in 90 minutes—using natural gas from the Pennsylvania wells for the first time in aeronautics. With the larger, 40-pound car she made the opening voyage at the World's Fair, St. Louis, July 4, 1904, instead of M. Santos-Dumont, taking me as passenger in her car for the first time in our twenty-eight years of individual air sailing. This car had also made the record "endurance flight" of 24 hours from the World's Fair, August 20, 1904.

In addition to the contents of this car as mentioned, it also held a collection of 1,000 photographs, in albums, and a series of larger mounted photographs showing flights of my 1905 motor skycycle airship, which had operated constantly outdoors during the season, from New York in August to Texas in December. Added to these contents was a line of sample balloon fabrics of all degrees of strength and lightness, made by me absolutely impregnable to hydrogen gas or spontaneous combustion, by means of special varnish applied repeatedly by machinery to 100-yard rolls of the fabrics, thus making them ready for immediate use in any shape.

The fact that all these various items when piled in the bottom of this wicker car left it still apparently empty, with room for two ordinary-sized gas balloons besides, will apprise the reader that economy of space and weight are important transportation features in aeronautics.

These few exhibits from my large stock of aeronautic curios will suggest some impression of the collective aggregation which amazed and confounded the visitor who saw it inside the gymnasium of the 69th Regiment Armory, where the Aero Club Show was held. The floor, the walls, the ceiling, the very air itself, was infested with a bewildering assemblage of all sorts of strange apparatus, the like of which had never been assembled before.

Standing upright on the floor, confronting the entering visitor, was a huge canvas structure outspread on bamboo poles extending to the very ceiling like a tent house. This was the big double- or triple-surface aeroplane of Mr. Israel Ludlow, which has lately occupied public attention by attempts to fly by means of a tugboat and an 80-horse-power automobile at Ormond Beach, Fla. It was the largest and most conspicuous exhibit, and the most incomprehensible to the inexpert visitor because of its great bulk, which required its display in a perpendicular position, instead of horizontal. Given force enough to move it, it unquestionably would rise and fly like any kite, leaving it to the aeronaut aboard to take his own chances of a safe fall and landing.

In front of the Ludlow aeroplane and over the doorway was suspended the beautifully complete airship frame of Dr. Julian Thomas, containing a small gasoline motor, screw propeller, and guiding appliances, above which was a collapsed gas envelope stretched in a long bundle suspended in webbing bands from the ceiling. This immediately made itself apparent to me through another sense than vision. I recognized the smell of advanced spontaneous combustion of oil-varnished fabric. While I looked and commented aloud, the envelope grew darker in color and smelled more vilely. In a moment more it reeked with smoke as well, and was next torn down in haste and its flame smothered by shaking it violently to quench its internal heat by douches of cold fresh air. It was then conveyed to the outer roof to cool off. The uninjured frame was restored to its place, and proved one of the most interesting and completely finished models on exhibition.

Next in line beyond the Thomas airship was the inflated airship of Mr. W. M. Keil, of Tuxedo Park, N. Y. This consisted of a very light symmetrical silk gas bag of spindle shape, one of several built by myself for various parties during the past season. This was kept completely inflated during the entire show, and was the only inflated airship in the room. Suspended below it was a long, light, triangular section frame, like the gunwales and keel of a boat stripped of its sides. Midway of this was an electric motor operating a screw propeller at one end of the boat, the screw shaft being flexible to permit of the screw blades facing in any direction to steer the vessel, while a large balanced aeroplane midway of the boat aided to raise or depress the vessel on a level during its flight. As a model of simplicity and effectiveness it was a notable exhibit.

Alongside Mr. Keil's "ballo-plane" and stretching midway of the room was suspended the framework, twin-cylinder motor, and screw of the Baldwin "California Arrow" of 1904, a comparatively close imitation of the No. 9 "Runabout" airship frame of M. Santos-Dumont hanging parallel with it, and having its aeronaut's car fixed close to the motor, while the Baldwin airship is without a car, the weight of the aeronaut necessitating his standing on the framework at a distance from the motor, to balance the weight of motor and screw. The chief difference in the two frames is the abrupt shortening of one end of the Santos-Dumont framework in this particular airship, its more refined, lighter, complex construction, its smaller screw propeller, and its higher speed. Each of these frames had suspended above them the collapsed gas envelopes used to support them.

Hung below the "Arrow" frame was my own exhibit of the 8-ounce pigeon basket, 11-pound netting car with its expanded Flying Dutchman screw and rudder, and my electric aerial torpedo. This high record vessel of 1900 has a 1-12-horse-power motor of 4½ pounds weight, driving a screw propeller of 30 inches diameter, 1,200 revolutions per minute and 12 miles per hour, with a 110-volt direct current. The gas bag which supports it is about the same size as that of the Keil ballo-plane, but it is sharper pointed. It is guided by balanced aeroplanes extended near its middle. A switch controls every movement at a distance in midair. It is a dynamite war vessel for navigating in air. Supported by its frame were photographs of the "Lone Star" skycycle. This has a seated car containing a high-speed gasoline motor located midway of its boat frame, which is 38 feet long and weighs 36 pounds. Its screw shaft projects 18 feet forward of the motor, supporting a 4-foot diameter screw, which revolves 1,200 to 3,000 times in 60 seconds. The screw of the "California Arrow" (which was directly above it) is 10 feet in diameter and revolves nominally 120 times per minute. The skycycle is steered by inclination of the aeronaut's body, or by movement of the balanced aeroplane rudder 18 feet in his rear. It runs equally well backward or forward, in which respect it differs from all others.

Beneath these exhibits, on tables, were displays of marine or awning supplies useful in aeronautics. Also a canvas model of an aerodrome or airship shelter. Across the room was the exhibit of Prof. A. Graham Bell, consisting of an extensive array of photo albums and several large models of his tetrahedral kites, composed of various units compounded to complete structures of any desired size, form, or function. In this connection Prof. Bell gave a very interesting running commentary during the moving picture exhibit of his kite flights in the lantern room above the gymnasium exhibit.

Over Prof. Bell's exhibit was suspended an expanding rubber "sounding balloon" equipment for automatic high-air investigations.

Beyond or behind the Ludlow aeroplane were a number of extraordinarily fine and light examples of wicker balloon cars of foreign make, one being large enough for an entire family, and like a house, "replete with every modern convenience." Aeronaut Leo Stevens also displayed a sample of the regular balloon car with appliances used in ascents, and hung in the main room above the automobile exhibits were also an airship, two balloons, and a parachute.

KEIL'S "BALLO-PLANE"—AN ELECTRICALLY-PROPELLED DIRIGIBLE BALLOON COMBINED WITH LIFTING AEROPLANES.

Nearly midway of the gymnasium hung Mr. William J. Hammer's exhibit of signal balloons displaying different colored electric lamps manipulated by keys below. Mr. Hammer's most conspicuous exhibit was an amazing show of photographs taken by himself and enlarged by the Aero Club, hung on the line extending nearly around the room, showing numberless foreign balloons and airships in groups and singly. Above these the walls were decorated with an array of kites of the tailless type, including, with some notable exceptions, the most prominent in use.

Many cases on the floor contained miscellaneous exhibits of aerial appurtenances, among which the United States government exhibit of patent models, instruments, and literature was prominent. Here I found several features which had been visitors to or products of my balloon farm.

Among unattached motors exhibited was the extremely light weight, 2-cycle, 2-cylinder, angular-framed gasoline engine of Mr. Charles E. Duryea, the well-known motor expert. The Curtiss Manufacturing Company showed the improved 4-cycle, 2-cylinder, 5-horse-power V-shaped motor first introduced in the "Montana Butterfly" at the balloon farm in 1903, and which afterward became notable in the Baldwin "Arrow." This company now makes a 2-cylinder 10-horse-power, and a 3-cylinder 15-horse-power motor on this principle.

An extremely novel motor was the reciprocating cyl-

*Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

inder Tygard engine, having a fixed piston with rotary valve and igniter, and which is a double acting, air cooled, explosion motor, with fewer parts than a single acting motor, and, on the whole, simpler, lighter, and more noiseless.

Mr. Stevens exhibited a 4-cylinder, 4-cycle, air-cooled motor of regular type, somewhat heavily built. A model of the working principle of the Hoyt motor was shown as a balanced high-speed machine. Other motors were catalogued in the aeronautic division, but I was unable to see them. It is a fact that the really ideal light-weight, air-cooled and automatically-controlled, high-power motor does not yet exist as a commercial product, though exceptionally competent motors have been specially constructed. A remarkably light motor is shown in the Langley steam and gasoline model aeroplanes, and the propelled, superimposed aeroplane of Mr. A. M. Herring, whose efforts in this line seem to me superior to the enlarged and successful machines of the Wright Brothers. Mr. Herring had a most remarkable exhibit of various flying or gliding machines displayed in his case or overhead, besides several wonderfully light and effective screw propellers. In the way of hélicoptères, or propeller-lifted and driven flying machines, Mr. Wilbur R. Kimball showed and operated several effective models, which he flew or sailed successfully. These were constructed with wire truss frames and twisted rubber bands which, as a source of power, excel everything else for light model building.

The Lilienthal gliding machine, exhibited by Mr. John Brisben Walker, was probably the most valuable pioneer man-flying or soaring machine at the show. I did not find the Chanute soaring aeroplane with which Mr. Avery made so many flights at the St. Louis World's Fair, but a similar machine was present, consisting of two superposed aeroplanes each about 18 x 6 feet surface, slightly curved from front to rear, and weighing, with guiding tail, about 18 pounds. This was in effective contrast with the Ludlow aeroplane first mentioned.

The defect in the Langley machine seems to be the trailing fore-and-aft arrangement of its wings or aeroplanes, instead of using the stronger, economic, and effective superposed arrangement of Chanute, Herring, and the Wrights. Among the scientific exhibits the wooden models of varying conical shapes shown by Prof. A. F. Zahm for estimating head resistance and friction seemed most valuable to me, because of my early investigations in the same line.

I found on exhibition no models or photographs contributed by Baldwin or Knabenshue of late airships. The Aero Club Show was generally "historic" to the extent of exhibiting nothing truly "up to date." At the same time, the show was greatly interesting in its collective assemblage of almost innumerable details of apparatus, and the collection of photographs which covered all accessible wall space. It was certainly the largest aeronautical show ever combined in America, if not also in Europe. It cannot fail to stimulate aeronautic art greatly, by showing to each investigator something of what others are doing, and to the world how much has really been done.

The most notable summary of the whole show is that it does not exhibit the present status of air navigation, for nothing was shown that was a real advance since 1900. The inference is that expert investigators are not showing their best work or developments, either from selfish motives, or because there exists today no commercial demand for aerial navigation other than as spectacular exhibits. This is the only field I have myself found thus far. The sporting instinct which expands automobiling, yachting, and motor boating has not come in yet, and the love of novel sensations in air sailing is not a sufficient lure at present, nor yet is the yearning of the wealthy for the brilliant prominence sure to illumine anyone who is first to be greatly successful among his fellows. Certainly the first show of the Aero Club of America will be greatly influential to this end, and the outdoor meetings of its members for aerial recreation will be a continuous incentive hereafter.

THE SUN'S DISTANCE.

By ALEXANDER W. ROBERTS, D.Sc., Lovedale, South Africa.

WHEN a country has to be surveyed, the first step in the undertaking, and very often the last, is to measure with all possible accuracy a base-line. To this standard line all other measurements of distance are related, and any error in its estimated length will of necessity be perpetuated all through the network of lines and triangles which form the materials of the survey. The accurate determination of the length of a base-line is, accordingly, the first essential in any terrestrial survey; and frequently more labor is expended on the measurement of this one line than in determining the length of the other thousand which depend upon it.

What a base-line is to terrestrial measurements the distance of the sun from the earth is to astronomical measurements. It is the base-line of celestial distances, the measuring-rod of the universe. The amount of our ignorance with regard to the sun's distance is accordingly a measure of the inaccuracy which qualifies all our astronomical tables of size and mass and distance. If we are faulty in our reckoning of the length of this fundamental astronomical unit, we are equally in error regarding every value derived from or dependent upon it.

Four hundred years ago Columbus set sail from the shores of Europe with an erroneous value of the earth's diameter to vitiate all his views of terrestrial proportions and distances. Thus, when he touched the western isles of America he thought he was somewhere in the golden East; he deemed the isles that rose out of a hitherto inviolate sea to be the long-sought Indies, and the name he gave them will remain for all time a memorial of his error. So also if some voyager set out over the star-studded sea of space, the value of the sun's distance that he took with him as a measuring log-line would color every judgment he formed of the size and weight and distance of the worlds he passed in his strange journey.

We need not wonder, therefore, that all through the history of astronomical research the problem of the sun's distance, "the noblest problem in astronomy," as a great English astronomer called it, has never lacked the attention of thoughtful men, and that one generation of astronomers after another have given of their best to secure a satisfactory solution to it. Even money, that commodity so often scarcer in scientific investigations than brains, has been spent freely and ungrudgingly by governments and individuals for the furtherance of the inquiry. It has been estimated that the various Transit of Venus expeditions, which had for their object the determination of the sun's distance, must have cost no less a sum than half a million sterling.

But, some one may urge, the progress of astronomy in our day has been, and is still, along other lines than the well-thrashed-out question of the sun's distance. The charting and photographing of the heavens; the detailed scrutiny of lunar and planetary markings; the search for new and variable stars; the spectroscopic analysis of light; the evolution of stellar and planetary systems; the why and the how, the whence and the whither, of material things; the great problems of the infinity, the eternity, the habitability of worlds—these are apparently the matters that chiefly occupy the attention of astronomers to-day.

Now this "new" astronomy has much to recommend it. It appeals to the lay mind because of its breadth, its attractiveness, even its humanity, much more than the older and more prosaic determinations of size and weight and distance; yet, notwithstanding the charm of the newer lines of research, they have failed as yet to oust some of the older problems from their acknowledged pre-eminence. It will ever be not only the "noblest" but also one of the foremost problems in astronomy to determine how far distant the sun is from our earth.

Instead, therefore, of the old, perhaps the very oldest, problem in astronomy being neglected amid the uprising of new and far-reaching questions, there has been going on silently and persistently—never more persistently than in the present day—one attempt after another to reduce the margin of error that surrounds the sun's distance to its lowest possible limit. Now the problem is attacked one way, now in another. Then, again, some fertile potential thought rises in the clear view of some master-mind. Ever and always the drift is truthward. As each worker drops the problem into the care of another, he knows he has carried it one step nearer the unattainable goal of absolute accuracy.

It may be of more than passing interest to indicate briefly the historical development of this outstanding problem—one of the oldest, one of the most important, one of the most interesting in the whole range of astronomical endeavor; interesting, because the history of the determination of the solar parallax—as the sun's distance is scientifically termed—is in no uncertain way an epitome of the history of astronomical progress and discovery.

The first determination we have any record of is that made by Hipparchus more than two thousand years ago. Of instruments the founder of exact astronomy had but few; but his was the comprehending wisdom to know that any instrument he could invent or devise would avail him nothing in a question of such refinement as the measurement of the sun's distance. From a consideration of the duration and magnitude of solar and lunar eclipses, he concluded that the distance of the sun was six hundred and fifty times greater than the earth's diameter; that is, about five million miles, a value eighteen times too small. The wonder is, not that Hipparchus was so far wrong, but that his genius enabled him to come to any conclusion at all.

For eighteen centuries this value of the sun's distance remained uncorrected. When in 1609 Kepler made known to the world the three famous laws that are known by his name, astronomy ceased to be an empirical science. There was henceforth to be no place for crude conjecture on the one hand or the speculations of the schoolmen on the other. Kepler's Laws, by relating the distances of the planets to their periods, and thus uniting by one common bond the members of the solar system into one ordered whole, raised the question of the sun's distance into the very forefront of the then newer problems demanding solution. For the determination of the sun's distance now meant the determination of the distance of every planet and comet circling round it.

To put the matter simply, Kepler's discovery did this signal service to astronomy: it drew an exact plan of the solar system. It is true the *size* of the scale was wanting; but since the plan was accurately drawn, a single measurement would yield the dimensions of every object that found a place on the plan. Let us suppose that by some mischance a certain map-maker forgot to put a scale of distances in the corner of his maps of Scotland. As a representation of *relative* distances the scaleless maps are as good as any we could get; but as charts yielding exact, *absolute* numerical measurements they are useless and worthless. We may, however, by a single determination create a definite scale of distances for the whole map. Let us, for example, measure with the utmost care the distance between Perth and Dundee, either by pacing it or surveying it; and, lo! forthwith we have the means of determining the distance that lies between the capital, Edinburgh, and every town and village and hamlet marked on the map. Our single measurement has given us a standard line by which we may reduce all relative distances to absolute values. Kepler drew an exact but scaleless map of the solar system; it only remained for some one to determine with great care *one* distance in that system.

The first determination under the new condition of things was made by Kepler himself. An examination of certain observations of Mars made by the Danish astronomer Tycho Brahé enabled him to arrive at a rough estimate of the distance of that planet. This distance gave him forthwith the distance of every other planet from the earth, the sun included. This latter distance, Kepler was able to say, could not be less than ten million miles. It must be remembered, however, that this determination rested on naked eye observations of Mars, and that the smallest angle discernible by the naked eye is ten times greater than the value of the angle on which the sun's distance depends. Until the discovery of the telescope it was accordingly impossible to make any further progress with the practical side of the problem.

A century after Kepler's day the French astronomer Lacaille, from telescopic observations of Mars made simultaneously in the northern and southern hemispheres, estimated the sun's distance from the earth at about ninety million miles, a conclusion which was supported by Cassini, another French astronomer.

Twice every one hundred and thirteen years Venus passes between the earth and the sun, and at these times of transit it is seen as a round black spot crossing the sun's disk. Let us suppose that as Venus passes across the face of the sun it leaves behind a dark trail to indicate the position and direction of the transit. Then, because Venus is much nearer to us than the sun is, the position of this dark trail or line will not be the same for all places on the earth's surface. An observer at Greenwich will see the trail a good deal farther south than will an observer at Capetown. This apparent displacement is called the relative parallax of Venus. It is evident that if we know the amount of this displacement, and also the distance from Greenwich to Capetown, we are in possession of all the data necessary for a determination both of the sun's distance and that of Venus.

In the eighteenth century the two transits of Venus took place in 1761 and 1769, and a discussion of the observations made at the many stations scattered all over the globe resulted in a value of the sun's distance equal to ninety-five million miles. So accordant were the various reductions that no ordinary confidence safeguarded the permanence of this value. For nearly a century it was accepted almost as a canon of astronomical faith that the sun was exactly ninety-five million miles distant from our earth. Indeed, half the nineteenth century had run its course before any doubt was expressed as to the accuracy of the figures that for so many years had found an apparently abiding lodging-place in astronomical text-books and journals.

In 1854 the celebrated Danish mathematician Hansen published his researches on the motion of the moon. Our satellite, as is well known, is pulled to no small extent out of her regular orbit by the attraction of the sun. The strength of this pull depends upon the distance of the sun. Now, Hansen found that the monthly "sagging" of the moon was greater than it would be if the sun were at a distance of ninety-five million miles; a distance of ninety-one and a half million miles would, according to his researches, agree better with the periodic errancy of the moon from its perfect allegiance to the earth.

At the same time that Hansen was investigating the motions of the moon, Leverrier, the co-discoverer with our Adams of the planet Neptune, was prosecuting his researches on the motions of the planets. These researches led him to the same result as that found by Hansen; and, to make matters more conclusive, the physical determination of the velocity of light by Foucault in 1862—namely, one hundred and eighty-five thousand miles per second—when combined with the time light takes to travel from the sun to the earth, in 1862 supposed to be four hundred and ninety-five seconds, resulted in a distance of ninety-one and a half million miles.

Thus the pendulum swung back in the direction of the older and smaller distance found by Lacaille and Cassini, when as yet modern astronomy was in the morning of its long and brilliant day. Still, although the larger distance was practically ruled out of court, men were unwilling to accept implicitly the newer values; for the loss of faith in the old meant also a want of confidence in the new.

Knowledge regarding the sun's distance was in this sad pass when a young Scotsman from Aberdeen took up the problem, and with the tenacity and courage of his northern race, halted not nor faltered till he had placed the matter for all time in the region of things certain and sure.

But to go back to our story: forty years ago the uncertainty with regard to the sun's distance amounted to no less than five million miles; that is, the distance might be anything between ninety and ninety-five million miles. The first real attempt to bring this ample area of error within reasonable limits was made in 1874 by Lord Lindsay, now Earl of Crawford and Balcarres. In that year he equipped his well-known Mauritius expedition for the determination of the distance of Juno. The head and heart of the expedition was

Lord Lindsay's assistant at Dun Echt, Mr. (now Sir David) Gill, whose skill and genius were to do so much for astronomy in after years. Old traditional ways of observing were forsaken, new instruments were devised, more improved methods of reducing the measures made were adopted, and altogether the Mauritius expedition marked the beginning of a new age in the science of exact astronomy—an age of consummate skill in making and marshaling observations and endless patience in dealing with them.

In announcing the value of the sun's distance arrived at—namely, ninety-three and a quarter million miles—the leaders of the expedition stated that "it is distinctly to be understood that the result arrived at is not presented as an example of the accuracy of which the [new] method is capable, but to be regarded as a first imperfect experiment made under somewhat trying and unfavorable circumstances, from which conclusions can be drawn as to the capabilities of the method for the future."

"The capabilities of the [new] method" were again put to the test by Sir David Gill in 1879, when at Ascension he made the classical series of observations of Mars which gave ninety-three million miles as the sun's distance. The curious may learn all about this noteworthy expedition—its inception, its history, its result—in that charming book, "Six Months in Ascension," by Lady Gill.

But both the Mauritius and Ascension expeditions were in a certain sense experimental. They were stepping-stones to a much more laborious and final determination of the sun's distance which has recently been carried through at the Royal Observatory, Capetown.

His Mauritius observations had assured Sir David Gill of the soundness of his newer methods of dealing with the problem; his Ascension observations warned him to leave Mars alone as a distance-goal, but to choose rather the star-like disk of a minor planet. The three asteroids Iris, Sappho, and Victoria were selected as the stars to be operated upon.

Twenty-two observatories associated themselves with the director of the Cape Observatory in securing the necessary preliminary observations; but the burden of the work—its direction, its energy, its character, its completeness—is alone due to the man who originated it.

It took ten long years, 1889-99, to bring the task to a satisfactory issue. There were sudden emergencies to be met, grave difficulties to be overcome, important and unexpected discoveries—as, for example, an error in the accepted value of the moon's mass shot forth from the maze of figures and lines and curves, which had to be dealt with; new and more extensive tables of logarithms had to be constructed; a new and improved system of reduction had to be invented. It was, indeed, for ten full years a daily pitched battle between Nature on the one side, reluctant as ever to surrender her secrets, and man on the other side, resolute—doggedly so—to wrest them from her.

We often pass the scientific values that find a place in our text-books—the distance of a star, the density of a gas, the velocity of a ray of light or of heat or of sound—with indifference, unmindful of the weary days and toilsome nights that men have spent in arriving at these results.

Sir David Gill's 1889-99 determinations of the sun's distance gave a final value of ninety-two million eight hundred and seventy-four thousand miles. The writer well remembers the strange feelings, almost amounting to awe, with which he looked upon the great bundles of foolscap used in working out the necessary calculations that culminated in the foregoing result. Gathered in one heap, they would make a pile fourteen feet high; placed end to end, the separate sheets would form a pathway ten miles long. Yet the ordinary man looks on the above value with the same feelings as he would on a number above a street-door.

The discovery of Eros in 1898 brought again the question of the sun's distance into prominence, for the position of this remarkable asteroid affords the most favorable method of determining the sun's distance as yet known. At an International Conference of Astronomers which met in Paris in 1900, a plan of observing Eros was outlined by which the certainty regarding the length of the celestial unit of measurement that Sir David Gill's magnificent work had begotten would be materially strengthened.

We have already stated in a previous portion of this paper that the history of the solar parallax is in a certain sense the history of astronomical progress. This is amply borne out in the case of the observations of Eros. For the first time in the history of the problem, photography was made use of in determining the exact position of the planet with reference to its surrounding network of stars; that is, a picture of Eros and its neighborhood was imprinted on a plate, and then, at leisure, this plate was placed under a powerful microscope and the various distances and directions read off. These quantities, when properly treated, ought to yield a very exact value of the sun's distance.

Two determinations were made public toward the close of 1904—one by the Oxford Observatory and the other by the Lick Observatory. The former finds from its series of photographs of Eros a value of the sun's distance equal to ninety-two million nine hundred and thirty-five thousand miles, and the latter ninety-three million miles.

It will make for completeness if in the present article reference is made to two indirect determinations of the sun's distance that have been carried to a successful issue within the past decade. Although they cannot be considered as determinations of the first rank, still they are of weight as affording supplementary proof of the value of the sun's distance obtained by the more direct methods we have just described.

We have already referred to what is called the physical method of finding the sun's distance. It was by this method that Foucault in 1862 gave prominence to the smaller distance of ninety-one and a half million miles. It consists in determining the velocity of light either from observations of the annual aberration of the stars or from actual physical experiments carried on on the surface of the earth. Then, since we know with considerable exactness the time light takes to travel from the sun to the earth, a simple sum in multiplication yields the result we are seeking.

Thus stated, the physical method seems simple enough; when put into actual practice, however, it is beset with difficulties. Still, no difficulty is quite unsurmountable, and so about twenty years ago certain American scientists found from experiments made with revolving mirrors that light travels at the rate of one hundred and eighty-six thousand three hundred and twenty-eight miles per second. Recent research indicates that light takes four hundred and ninety-eight seconds to come from the sun. These two values multiplied together give as a product ninety-two million seven hundred and ninety-one thousand. This is the distance of the sun in miles as obtained by the physical method.

We have also referred to the indirect method of determining the sun's distance, called the gravitational method. It was by following out this method that Hansen in 1854 first raised doubts regarding the accuracy of the older values. We may witness the principle that underlies the gravitational method every time we bring a powerful magnet near a compass-needle. The sensitive, slender steel band responds to the attraction of the magnet and moves out of its true direction a greater or less degree according as the magnet is near or far. Indeed, if the magnet were hidden away, one skilled in such matters could readily find it from the displacement of the needle as it is taken from spot to spot in the vicinity of the undiscovered disturbing influence.

As the magnet acts on a needle, so the sun acts on the moon, now accelerating its rate, now retarding it, in its journey round the earth. Astronomers knew of this periodic inequality in the moon's motion more than two thousand years ago, although they could not explain its cause. Now, the amount of variation in the rate and from the road which the moon would follow if there were no sun can be determined from observation, and this amount when known yields, among other things, a value of the sun's distance.

During the past twenty years Prof. Newcomb, of Washington, has been dealing with the problem of the sun's distance from this side, and his results have recently been made known to the astronomical world. He finds that certain well-known variations in the movements of the moon and planets can be well accounted for by assuming the sun's mean distance from the earth to be ninety-two million nine hundred thousand miles.

Perhaps it would savor too much of the text-book to bring all these results together in the form of a table. If we do so, our apology is that such a table does not find a place in any text-book yet published, and also that such an ordered presentation of important scientific results must be of more than common interest. The most important recent determinations of the sun's distance are:

Determination.	Distance.
Observations of Victoria (Sir David Gill)	92,874,000
Observations of Eros (Oxford Observatory)	92,935,000
Observations of Eros (Lick Observatory)	93,000,000
Physical Method (Professor Newcomb and Dr. Chandler)	92,791,000
Gravitational Method (Professor Newcomb)	92,900,000

These five values when combined give as a mean value of the sun's distance ninety-two million nine hundred thousand miles.

Our article has already labored into undue proportions, but two remarks on this value require to be made: First, it is a mean value. As the earth moves round the sun in an elliptical orbit, it is always approaching or receding from the sun. The amplitude is small, but nevertheless it is there. In the early days of January of each year the sun is ninety-one million three hundred thousand miles distant from the earth; and six months later, in the beginning of July, it is ninety-four million five hundred thousand miles away. Between these two values it ever swings to and fro. Then, again, it is a dependent value. It depends upon the value of the earth's diameter that we consider most correct. And thus we come back to earth again, as we always must. We are tethered to it even when we are casting sounding-lines across the universe.

To determine the number of miles that lie between us and Sirius requires that we first ascertain the distance of the sun. But we cannot arrive at a knowledge of this important standard without previous and accurate knowledge of the length of the earth's diameter. And the value of this terrestrial unit of length depends upon surpassingly refined measurements of certain base-lines; while our base-lines, again, whether out on the Cape Flats, within sight of the Solent, or away in the frozen plains of northern Russia, are only multiples of a standard bar that a little box can hold. Every day the links in this connecting chain that relates a platinum rod one yard long to almost infinite stellar distances are being strengthened.

Now it is the sun's distance, now it is a surveyor's web of lines running right across the African continent, now it is the abysmal distance of a star, now it is the length of a bar no longer than a man's arm; yet the unity and spirit of the endeavor is a single whole. And that whole is to bring all nature, remote or near, vast or minute, massive or meager, within the domain of definite facts and exact numerical relations and proportions.—Chambers's Journal.

SCIENCE NOTES.

A striking proof that sewage-polluted water may become the effective vehicle of the actual poison of disease was furnished through the cholera epidemic in London in 1866, but the theory that water is one of the most dangerous carriers of infection of cholera and of typhoid fever may be said to date from 1872, and to have been the result of the careful investigation of the typhoid fever epidemic in that year in Lausen, Switzerland. To-day we recognize as one of the best established theories of sanitary science that both cholera and typhoid fever are water-borne diseases, and that the primary cause of the large death rate from typhoid fever is due to the use of polluted waters.

The mathematician mentally constructs an ideal mechanical system or model, which is intended to represent in its leading features the system he wants to examine. It is often a task of the utmost difficulty to devise such a model, and the investigator may perchance unconsciously drop out as unimportant something which is really essential to represent actuality. He next examines the conditions of his ideal system, and determines, if he can, all the possible stable and unstable configurations, together with the circumstances which will cause transitions from one to the other. Even when the working model has been successfully imagined, this latter task may often overtax the powers of the mathematician. Finally it remains for him to apply his results to actual matter, and to form a judgment of the extent to which it is justifiable to interpret nature by means of his results.

Anthropology is the science of man. In a broad sense it deals with all mankind and their attributes. Its aims and purposes are connected with man as an organism, and as the type of the class of living things distinguished by mentality; also it deals with mankind as an assemblage of varieties or races, and as social creatures united by language and law and organized in families, communities, societies, commonwealths, and nations. In like manner the science in its broader aspects deals with man as a producer or creator of artificial things, and so as a progressive power in the conquest of lower nature; and in its highest aspect the science deals with the development of both man and his works, and seeks to trace the paths of human progress not only in the interest of definite knowledge concerning our own kind, but in the hope of wiser guidance toward future progress.

Standardizing Thermometers.—The experimental laboratories of the French National Conservatory of Arts and Trades has undertaken the verification of medical thermometers, the scale adopted being the international one. The limits of error admissible are 0.15 deg., on the indication furnished by the thermometer in a bath carried to a given temperature, and 0.15 deg. on the maintenance of this indication when the thermometer is taken from the bath and cooled. As a result of this, two thermometers, certified by the laboratory cannot differ from each other by more than 0.3 of a degree. Out of a list of 440 thermometers tested, 139, or 31 per cent only, satisfied the above conditions. Thus, during a course of years, many patients have had their temperatures taken with inaccurate thermometers. The instruments accepted by the laboratory are to be accompanied by a certificate giving the indications engraved on the thermometer.

The early attempts at grape growing on the Atlantic coast were generally unsuccessful, having been confined almost exclusively to the introduction and growing of European varieties. It has only been since attention has been given to improving and cultivating our native grapes and to counteracting the injury of insects and vine diseases that grape culture in that region has gradually developed into an important industry. It will be of interest here to note that not only has America, in improving and cultivating her native grapes, given to the world a new fruit, but it has been the direct means of re-establishing the European vineyards upon stocks resistant to the attacks of the phylloxera or root-louse, which has already destroyed a large portion of the vineyards of the Old World. All the successfully re-established vineyards are either American varieties or those of American parentage, or hybrids of these and Viniferas, or Vinifera varieties grafted on such sorts. In California, where the Viniferas have found a congenial home, and which bids fair to surpass any like area of the world in grape production (for, while in Europe they produce 150 to 400 gallons of wine to the acre, in California it is quite common for the production to reach five times that amount and even more), there has been a similar experience. Thousands of acres have already been destroyed, and these, in order to be re-established and become permanent and lasting vineyards, will have to be grafted on resistant stock. It should also be stated that the industry in this country is in its infancy. Our successful experience has nearly all been during the last half century, and we have every reason to feel elated over what has already been accomplished. Many phases of the development have, however, scarcely been commenced. The Scuppernong (*Vitis rotundifolia*), for instance, a native species, perhaps more immune to disease and insect injury than any other, needs very little care and cultivation to produce enormous crops on suitable lands, of which there are thousands

of acres now idle along the Atlantic coast and in the Gulf States. From this, a large and profitable industry can be developed.

TRADE NOTES AND FORMULÆ.

To Fireproof Wood.—For this purpose a paint may be employed consisting of equal parts of fluid chloride of lime, the by-product of gelatine works, and fatty lime of pasty consistency.—Technisches Centralblatt.

Bronzing of Zinc.—Mix thoroughly 30 parts of sal ammoniac, 10 parts of oxalate of potash, and 1,000 parts of vinegar. Apply with a brush or a rag several times, until the desired tint is produced.—France Horlogère.

To Fasten Ebonite on Metal.—To attach ebonite on metal, soften and boil Cologne glue until it thickens. Then add clean ashes and form a homogeneous paste. This is to be used hot for working. While drying, press the pieces together a little.—Formulaire.

Liquid for Sanitary Spraying.—This, for use in the chambers of the sick, is composed of 10 parts of eucalyptol, 3 parts of thyme oil, as much lemon oil, and the same quantity of lavender oil, in 110 parts of alcohol of 90 deg. To a pint of water add a teaspoon of this liquid.—Jour. Parf. et Sav.

Ink for Writing on Polished Metallic Surfaces.—Dissolve 20 parts of resin in 150 parts of alcohol, and add 1 part of methylene blue. In a separate dish dissolve 35 parts of borax in 250 parts of water and add to the first liquid. The ink can be used at once.—Zeitschrift Anal. Chem.

Ink for Writing on Glass.—Dissolve in about 500 grammes of water, 36 grammes of sodium fluoride and 7 grammes of sulphate of potash. Make another solution of 14 grammes of zinc and 65 grammes of chlorhydric acid in 500 grammes of water. For use, mix equal parts of the two solutions and write on the glass with a pen or pencil. In half an hour a deadened inscription will appear.—Corps Gras.

Dressing for Linen.—White starch powder, 51 kilogrammes; pulverized borax, 25 kilogrammes; stearic acid, 1.3 kilogrammes; rectified alcohol, 1.3 kilogrammes. The stearic acid is dissolved hot in alcohol, and the starch is added, mixing well, and allowing the mass to repose in the air until the alcohol is totally evaporated. Then the borax is added, and the whole worked up in the mixing apparatus. For use, a coffee-spoonful of the composition is mixed with half a pound of starch and applied as usual.—Corps Gras.

Wood Dye.—Chips of wood are first heated in a bath containing from 5.5 to 6 parts of colorant to 1,000 to 1,100 parts of water. The heating should occur under pressure of 50 to 100 kilogrammes per square decimeter, according to the grain of the wood; the pressure should be kept up from two to six hours. The wood is dried before polishing. If in large quantity it is mordanted, either with soap or with tannin, according as an acid or a basic colorant is to be employed. The colorant is applied with a brush, and generally three coats are necessary.—La Nature.

Plating Iron and Other Metals with Aluminium.—To plate iron and other metals with pure aluminium, deoxidize the pieces with a solution of borax and place them in an enameling oven, fitted for receiving metallic vapors. Raise the temperature to 1,000 or 1,500 deg. C. Introduce the aluminium vapors generated by heating a quantity of the metal on the sand bath. When the vapors come in contact with the metallic surfaces, the aluminium is deposited. The vapors that have not been used or are exhausted may be conducted into a vessel of water.—Chemische Revue.

Peach Flower Perfume.—This designation is, perhaps, rather ambitious, as none of the flowers of the peach tree are used in the composition; but it has an agreeable odor resembling the natural perfume. It is obtained by digesting together for a few hours 4 grammes of lemon oil, 1 gramme of balsam Peru, ½ gramme of almond oil, 75 grammes of orange flower water, 20 grammes of jasmin oil, and 200 grammes of alcohol. Shake often, and leave at absolute rest for a week. Finally, decant the clear portion of the liquid.—Jour. Parf. et Savon.

Potato Jelly.—The French Association of Sugar Manufacturers recently held a competition for household preserves under the patronage of the municipality of Lyons. The first prize was awarded to Mme. Beauville for a jelly of potatoes which astonished the jury. This is the recipe for her various preparations: Prepare a concentrated syrup of sugar, and while boiling throw in the potatoes (presumably cut up into small pieces) and continue boiling for 30 or 40 minutes. That is sufficient to evaporate the water. The preserves contain no foreign substances facilitating coagulation or clarification. The proportions employed are the following: 5 pounds of sugar for 5 pounds of fruit.

Armenian Cement.—This is a cement or glue employed by Oriental jewelers. It is made by dissolving 10 parts of gum mastic in 60 parts of absolute alcohol, and dissolving separately 20 parts of fish glue in 100 parts of water on the water bath with gentle fire, and adding 10 parts of alcohol of 50 deg. Then dissolve 5 parts of ammoniacal gum in 25 parts of alcohol of 50 deg. Mix the first solution with the second, stir well until assured of complete mingling, then add the ammoniacal gum and stir again. Finally, put the whole on the water bath under moderate heat, in order to bring down the preparation by evaporation to 170 parts only.—La Nature.

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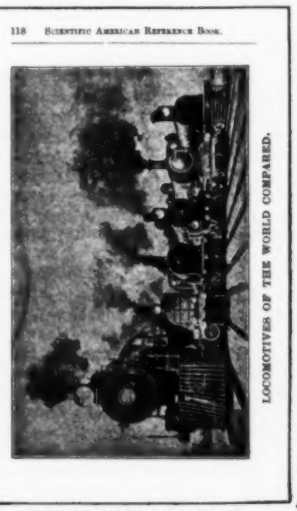
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